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BLACK AND VEATCH KANSAS CITY MO
NATIONAL DAM SAFETY PROGRAM, HARRISON COUNTY DAM C-2 (MO 10614)--ETC(U)
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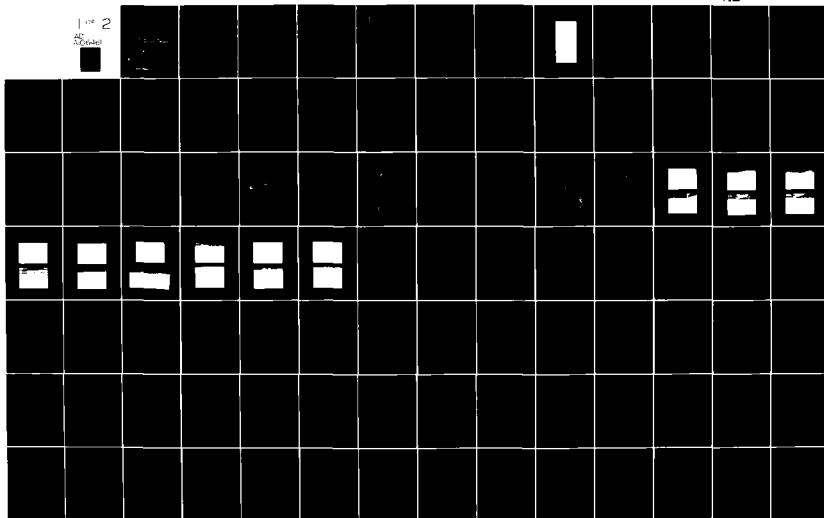
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MISSOURI-GRAND-CHARITON BASIN

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**HARRISON COUNTY DAM C-2
HARRISON COUNTY, MISSOURI
MO 10614**

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PHASE 1 INSPECTION REPORT NATIONAL / DAM SAFETY PROGRAM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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**HARRISON COUNTY DAM C-2
HARRISON COUNTY, MISSOURI
MO 10614**

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



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PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

MARCH 1981

HARRISON COUNTY DAM C-2
HARRISON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10614

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF
ST. LOUIS DISTRICT CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

MARCH 1981



DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Harrison County Dam C-2 (MO 10614).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

9 JUL 1981

Date

APPROVED BY:

SIGNED

Colonel, CE, Commanding

10 JUL 1981

Date

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Harrison County Dam C-2
State Located	Missouri
County Located	Harrison County
Stream	Panther Creek
Date of Inspection	3 March 1981

Harrison County Dam C-2 was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately six miles downstream of the dam. Within the estimated damage zone are four dwellings and two farm buildings. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will not pass the probable maximum flood without overtopping but will pass 40 percent of the probable maximum flood. The spillways will pass the flood which has a one percent chance of occurrence in any given year (100-year flood). The spillway design flood recommended by the guidelines is 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were erosion at the downstream toe of slope and at both abutment/embankment interfaces, a wet area downstream of the dam, the growth of trees on the embankment, animal burrows in the embankment, irregularities

in the downstream slope, vehicle tracks on the crest of the dam, and an inoperable slide gate at the low level inlet to the principal spillway drop structure. Seepage analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Edwin R. Burton

Edwin R. Burton, PE
Missouri E-10137

Harry I. Callahan

Harry I. Callahan, Partner
Black & Veatch



OVERVIEW OF DAM

1. The dam is located in the state of California, near the city of San Francisco.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HARRISON COUNTY DAM C-2

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
SECTION 1 - PROJECT INFORMATION		
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	3
SECTION 2 - ENGINEERING DATA		
2.1	Design	6
2.2	Construction	6
2.3	Operation	6
2.4	Geology	6
2.5	Evaluation	7
SECTION 3 - VISUAL INSPECTION		
3.1	Findings	8
3.2	Evaluation	10
SECTION 4 - OPERATIONAL PROCEDURES		
4.1	Procedures	11
4.2	Maintenance of Dam	11
4.3	Maintenance of Operating Facilities	11
4.4	Description of Any Warning System in Effect	11
4.5	Evaluation	11
SECTION 5 - HYDRAULIC/HYDROLOGIC		
5.1	Evaluation of Features	12
SECTION 6 - STRUCTURAL STABILITY		
6.1	Evaluation of Structural Stability	14
SECTION 7 - ASSESSMENT/REMEDIAL MEASURES		
7.1	Dam Assessment	17
7.2	Remedial Measures	17

TABLE OF CONTENTS (Cont'd)

LIST OF PLATES

<u>Plate No.</u>	<u>Title</u>
1	Location Map
2	Vicinity Topography
3	Dam Plan
4	Principal Spillway & Typical Section
5	Dam Crest Profile & Cross Section
6	Emergency Spillway Profile & Cross Section
7	Boring Plan and Logs
8	Photo Index

LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Title</u>
1	Upstream Face of Dam
2	Upstream Face of Dam at Waterline
3	Crest of Dam Looking West
4	Crest of Dam Looking East
5	Downstream Face of Dam Looking West
6	Downstream Face of Dam Looking East
7	Principal Spillway Drop Inlet Structure
8	Principal Spillway Weir
9	Principal Spillway Pipe Outlet
10	Channel Downstream of Principal Spillway

TABLE OF CONTENTS (Cont'd)

LIST OF PHOTOGRAPHS

<u>Photo No.</u>	<u>Title</u>
11	Emergency Spillway Looking Upstream
12	Emergency Spillway Channel Looking Downstream
13	Dike Along Left Bank of Emergency Spillway
14	Erosion at Toe of Downstream Face of Dam
15	Erosion at Left Abutment - Upstream Face of Dam
16	Drainage Ditch Downstream of Dam
17	Animal Burrow near Crest of Dam
18	Animal Burrow on Upstream Face of Dam

APPENDIX

Appendix A - Hydrologic and Hydraulic Analyses
Appendix B - Geologic Investigation & Design Memorandum

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Harrison County Dam C-2 be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of Panther Creek (see Plate 1). The watershed is an area of low hills with fairly steep rugged terrain devoted primarily to grassland pasture and meadow. Timber occurs mostly adjacent to stream channels and along drainage ways. The dam is approximately 1,500 feet long along its crest and 54 feet high. The dam crest is 13 feet wide. The upstream slope of the dam is broken by a 10 foot wide berm about 12 feet below the crest and another berm just below the principal spillway level. The upstream slope is faced with riprap below the upper berm. The downstream face of the dam slopes uniformly from the crest to a graded 10 foot wide berm about 36 feet below the crest, then slopes to the valley floor below the dam.

(2) The principal spillway is a typical SCS design drop inlet structure with a pipe outlet. The rectangular reinforced concrete drop inlet structure has an overflow weir on two sides and is protected by an angle-iron trash rack supported by concrete walls. The outlet from the drop structure is through a 48-inch diameter reinforced concrete pipe that passes under the dam to a plunge pool and natural stream channel below the dam. The drop structure has a gated reinforced concrete pipe low-level inlet.

(3) The emergency spillway is a 180 foot wide trapezoidal channel cut through the natural abutment around the right end of the dam. The emergency spillway has a natural limestone floor and right bank in the reach at the end of the dam. The downstream reach is grass lined in soil with 8-foot wide dikes along each bank. The dam embankment is protected from emergency spillway flows by a dike along the left bank of the spillway. Reference to right or left as used in this report is defined as right or left while facing in a downstream direction.

b. Location. The dam is located in east central Harrison County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an area shown on the United States Geological Survey 15 minute series quadrangle map for Blythedale, Missouri in Section 36 of T65N, R27W. The lake is shown on the USGS 7.5 minute orthophotograph for Blythedale NW, Missouri.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the intermediate size category. An intermediate size dam is classified as having a height less than 100 feet, but greater than or equal to 40 feet and/or a storage capacity less than 50,000 acre-feet, but greater than or equal to 1,000 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Harrison County Dam C-2 has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Harrison County Dam C-2, the estimated flood damage zone extends approximately six miles downstream of the dam. Within the estimated damage zone are four dwellings and two farm buildings. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by Jess Hale, Ridgeway, Missouri 64481.

f. Purpose of Dam. The dam forms a 67-acre lake used for recreation, flood control, water supply, and soil stabilization.

g. Design and Construction History. Data relating to the design and construction of the dam were available from the U.S. Department of Agriculture, Soil Conservation Service at Columbia, Missouri. Construction of the dam was completed in October, 1972 by Turner Construction Company, Maryville, Missouri.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled spillways all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 5,831 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is over a weir of the concrete drop inlet structure to a 48-inch reinforced concrete pipe through the embankment.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 20,910 cfs (Probable Maximum Flood Pool El. 931.6).

c. Elevation (Feet above m.s.l.)(Survey elevations).

(1) Top of dam - 928.3 (see Plate 5)

(2) Principal spillway crest - 906.3

(3) Emergency spillway crest - 920.4

(4) Streambed at toe of dam - 873.8

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1.7 miles \pm (Probable maximum flood pool level)

(2) Length of normal pool - 4,600 feet \pm (Principal spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 3,963

(2) Principal spillway crest - 424

(3) Emergency spillway crest - 2,079

(4) Design surcharge - 1,520 \pm

f. Reservoir Surface (Acres).

(1) Top of dam - 471

- (2) Principal spillway crest - 67
- (3) Emergency spillway crest - 161

g. Dam.

- (1) Type - Earth embankment
- (2) Length - 1,500 feet \pm
- (3) Height - 54 feet \pm
- (4) Top width - 13 feet
- (5) Side slopes - upstream face 1.0 V on 2.5 H design, 1.0 V on 2.6 H field measured, downstream face 1.0 V on 2.5 H design, and 1.0 V on 2.6 H field measured (See Plates 4 & 5).
- (6) Zoning - Zone 1 - Core CH material, Zone 2 - upstream and downstream embankment CL material, Zone 3 upstream face limestone riprap, Zone 4 - lower upstream face limestone and shale rock (See Plate 4).
- (7) Impervious core - CH material (See Plate 4).
- (8) Cutoff - Impervious core trench.
- (9) Grout curtain - None.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway (Survey elevations).

- (1) Type - Overflow weir drop inlet structure to reinforced concrete pipe through dam.
- (2) Crest elevation - 906.3 feet m.s.l.
- (3) Inlet invert elevation - 887.4 feet m.s.l.
- (4) Outlet invert elevation - 884.5 feet m.s.l.
- (5) Gates - Slide gate at low level inlet to drop structure.
- (6) Upstream channel - None.
- (7) Downstream channel - Principal spillway pipe discharges to a riprap lined plunge pool, then to the natural stream below the dam.

j. Emergency Spillway (Survey elevation).

- (1) Type - Trapezoidal open channel.
- (2) Width of channel - 180 feet.
- (3) Crest elevation - 920.4 feet m.s.l.
- (4) Gates - None.
- (5) Upstream channel - Each of the two arms, forming the lake contain a few trees.
- (6) Downstream channel - Grass lined to natural stream below dam.

k. Regulating Outlets ("As-Built" elevation).

- (1) Type - Slide gate low level inlet to drop structure.
- (2) Inlet invert elevation - 888.5 feet m.s.l.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data in the form of a detailed geologic site investigation report, a design memorandum from the SCS Soils Mechanics Laboratory, "As-Built" drawings and hydrologic/hydraulic data were made available by the Soil Conservation Service. The geology report and design memorandum are included herein as Appendix B. Pertinent data from the "As-Built" drawings are included on Plates 3, 4, & 7. Hydrologic/Hydraulic data provided is included in Appendix A.

2.2 CONSTRUCTION

Construction records in the form of "As-Built" drawings were provided for the dam and spillways. A log of construction is available in the project file through the Soil Conservation Service, Columbia, Missouri office.

2.3 OPERATION

Operational records and documentation of past floods were unavailable.

2.4 GEOLOGY

The site of the dam and reservoir is located across a broad, steep-sided valley cut by Panther Creek. The dam impounds this creek and the drainage from its watershed in Harrison County, Missouri.

The site is located within the Iowa and Missouri Till Plain. The soils of the area consist predominantly of silty clays (CL) with sand and gravel intermixed developed in Kansas age glacial till on the uplands and hill slopes, and silty clay to clayey silt (CL-ML) alluvium and terrace deposits on the valley floor. In addition there is a layer of silty sand (SM) that is present about 1 foot above the bedrock in the valley that is continuous and is assumed to be permeable. Bedrock consists of the interbedded limestones and shales of the Pennsylvanian age Kansas City Group and is buried to a depth of generally greater than 10 feet.

The foundation of the dam is recent alluvial silty clay to clayey silt (CL-ML) overlying the Winterset Limestone of the Dennis Formation to a thickness of 6 to 10 feet. The emergency spillway is cut through this limestone formation at the centerline of the dam.

2.5 EVALUATION

a. Availability. Engineering data were obtained from the Soil Conservation Service as noted in Section 2.1.

b. Adequacy. Engineering data were available from which to make an assessment of the design and construction. Seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency. These seepage analyses should be performed and made a matter of record.

c. Validity. The available engineering data on the design and construction were determined to be valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Harrison County Dam C-2 was made on March 3, 1981. The inspection team consisted of Edwin Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and David Rensing, hydrologist. The dam appeared to be in satisfactory condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. No cracking, sliding, sloughing or other signs of settlement or instability were observed. There were no instruments on the dam to measure performance.

A wet area was observed downstream of the dam between the principal spillway outlet and the emergency spillway (Photo 16). The inspection team believed that this wet area was due to poor drainage of local runoff. The downstream slope of the embankment had minor irregularities which appeared to be the result of cattle traffic. These irregularities consisted of two or three lines located about one quarter of the way up the slope from the toe where the slope was interrupted by a vertical drop of approximately one foot followed by a flat slope for about one and one half to two feet. Minor erosion was observed on the downstream face of the dam which appeared to have occurred before the grass cover had become established. Erosion gullies were beginning to develop at the embankment-abutment interfaces (Photo 15), on the upstream and downstream side at the left abutment, on the downstream side at the right abutment, and along the toe of the downstream slope (Photo 14) between the left end and the principal spillway. Riprap slope protection in good condition was provided on the upstream face below the upper berm (Photo 2). Slope protection was provided on the downstream slope, the crest, and the upstream slope above the riprap by a good stand of fescue grass. The grass was maintained by cattle grazing. Vehicular traffic has worn tracks and bare areas across the crest of the dam (Photos 3 & 4). Several small trees, 1-inch in size, were growing in the riprap on the upstream face (Photo 2). A few animal burrows were observed on the crest and upstream face of the dam (Photos 17 & 18). There was no evidence to indicate that the dam has ever been overtopped.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The drop inlet structure of the principal spillway appeared to be in good condition (Photos 7 & 8). No cracking, spalling, or other evidence of concrete deterioration was observed. The angle-iron trash rack was secure with no signs of rust. One log, 8 inches in diameter, was jammed against the trash rack but probably would not reduce the capacity of the

inlet. A low-level inlet for lake drawdown was provided on the reservoir side of the structure through a slide gate. The gate was in a closed position. The inspection team was unable to operate the gate. A small stream of water, estimated at approximately 1/2 gallon per minute, was leaking from the side of the gate. The inspection team was unable to measure the gate but estimated its size to be 18 inches in diameter.

The inspection team observed the downstream end of the 48-inch reinforced concrete principal spillway pipe (Photo 9). Three pipe sections supported by a concrete cradle were exposed. The pipe joints appeared to be tight with no obvious movement. The alinement of the pipe appeared to be true and straight when looking through the pipe from the downstream end. Some minor erosion and undercutting of the pipe cradle was observed. Erosion was noted in the plunge pool below the pipe outlet. The elevation of the bottom of the plunge pool at the pipe outlet was field surveyed to be about three feet lower than shown on the "As-Built" drawings.

The emergency spillway is a channel cut into the embankment at the right end of the dam (Photos 11 & 12). The channel was in good condition with no evidence of erosion. The floor of the spillway to about 50 feet downstream of the dam centerline was limestone bedrock. The channel floor for the downstream reach was protected from erosion by a good covering of fescue grass. The embankment was protected from flows in the emergency spillway by an earth dike along the left spillway bank (Photo 13). The dike was also grass covered.

There was no development in the spillway area which would suffer damage due to flow through the spillways.

d. Geology. The soils in the area of the dam and reservoir consist of low plastic silty clays developed in glacial till on the uplands and hillsides and alluvial silty clays to clayey silts on the valley floor. Depth to the interbedded limestones and shales of the Pennsylvanian age Dennis Formation is greater than 10 feet.

A sample of the material in the embankment was taken with an Oakfield sampler from near station 6+00 on the crest. The materials sampled were visually classified for engineering properties as silty sand (SM) top soil for the upper 1-1/2 feet and dark brown silty clay (CL) glacial till from 1-1/2 feet to 2-1/2 feet. The inspectors suspect that the lower sample was from core material. Both abutments are in stiff glacial till classified as silty clay (CL) material.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The lake has two arms with Panther Creek forming the east arm and a lesser tributary forming the west arm. The upstream channel to the lake contains a few trees. The lake was noted to be clean with no appreciable siltation.

f. Downstream Channel. The spillways discharge to a natural stream channel containing no obstructions.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control.

The wet area observed downstream of the dam is believed to be due to poor drainage of local runoff. However, it should be observed during dry periods. If it does not begin to dry up during dry weather, then it should be considered a seep area and monitored regularly.

The gully erosion observed at the abutment-embankment interfaces and at the toe of the downstream slope is where local runoff concentrates. Erosion control in these areas may require riprap or paving.

The irregularities observed on the downstream slope are believed to be the result of cattle traffic on the slopes and are not considered a problem at this time. If the slope irregularities become larger, however, it could lead to erosion and/or sloughing.

The vehicle tracks across the crest of the dam do not constitute a problem at this time but could result in erosion of the crest if not corrected.

The growth of trees on the embankment, if allowed to go unchecked, could cause deterioration of the embankment and displacement of the riprap slope protection. This could lead to erosion of the embankment. The roots of trees can loosen the embankment material and create voids through which water can pass.

Burrowing animals will continue to damage the embankment unless a program is undertaken to eliminate them. Piping failure of the embankment has resulted in similar small earth dams as the result of burrowing animal damage.

The low level slide gate inlet to the principal spillway drop structure is to provide for drawdown of the reservoir which is a safety feature. The design drawdown time is ten days. The inoperable condition of the gate will hinder and delay any drawdown operations if a crisis were to arise. The observed leakage from the gate is not considered a safety deficiency but if not corrected it will probably worsen and could result in draining the reservoir.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

Maintenance is the responsibility of the Soil and Water Conservation District for the Panther Creek watershed. There was no evidence that a maintenance program was in effect. The grass cover is maintained by cattle grazing.

4.3 MAINTENANCE OF OPERATING FACILITIES

The slide gate at the low level inlet to the drop structure has not been maintained in an operating condition.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be implemented to include removal of trees from the embankment and control of animal burrowing. The slide gate should be repaired and maintained.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Limited design data pertaining to hydrology and hydraulics were available from the Soil Conservation Service (SCS). Independent calculations were performed for this evaluation in accordance with the guidelines referenced in Section 1.1c and the St. Louis District Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 22 August 1980. The SCS data provided for an emergency spillway design for a 2 percent chance (50-year) storm of 6 hours duration. The design resulted in an emergency spillway maximum discharge of 718 cubic feet per second at a flow velocity of 5.7 feet per second and a maximum water surface elevation of 922.2. This design considered routing through three upstream structures. The freeboard design by SCS considered a 13.70 inch rainfall on an uncontrolled watershed to produce a maximum emergency spillway discharge with a maximum water surface elevation of 927.9. A copy of the design data is included in Appendix A.

b. Experience Data. The drainage area and lake surface area are from the "As-Built" data and from the USGS Blythedale, Missouri Quadrangle Map. The dam and spillway layouts are from a survey made during the inspection and from "As-Built" drawings.

c. Visual Observations.

(1) The principal spillway appears to be in good condition. The lake level at the time of the inspection was at the inlet weir crest with a small flow going over the weir. One large log was against the trash rack but was not effecting the spillway capacity. The spillway outlet pipe discharges with a free outfall into a plunge pool then to the natural channel of Panther Creek. There were no obstructions to flow through the principal spillway.

(2) The emergency spillway appeared to be in good condition. The floor of the spillway adjacent to the end of the dam was exposed limestone bedrock. The downstream spillway channel was grass lined. There were no obstructions to flow in the emergency spillway.

(3) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway will pass 40 percent of the probable maximum flood without overtopping the dam. The spillway will pass the one percent probability flood as indicated by

comparison of the one percent probability rainfall total to the rainfall totals of the various ratios of the probable maximum storm. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of intermediate size should pass 100 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 135 cfs of the total discharge from the reservoir of 13,345 cfs. The estimated duration of overtopping is 2.1 hours with a maximum height of 0.7 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 15,900 cfs of the total discharge from the reservoir of 36,810 cfs. The estimated duration of overtopping is 4.8 hours with a maximum height of 3.3 feet. The embankment could be jeopardized should overtopping occur for these periods of time. The good stand of grass on the embankment will reduce the potential for erosion.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately six miles downstream of the dam. Within the estimated damage zone are four dwellings and two farm buildings. Contents of the estimated downstream damage zone were verified by the inspection team. There does not appear to be any flood plain regulations or other constraints in force to limit future downstream development.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in section 3, paragraph 3.1b.

b. Design and Construction Data. Design data relating to the structural stability of the dam were available from the United States Department of Agriculture, Soil Conservation Service which consisted of Detailed Geologic Investigation of Dam Sites, 12-13-67 and Memorandum to James M. Dale, State Conservation Engineer from Lorn P. Dunnigan, Head Soil Mechanics Laboratory, SCS, dated April 30, 1968.

"As-Built" construction drawings, dated October 3, 1972 were available from the Soil Conservation Service.

As reported in the SCS data, samples for testing were obtained from borings located within the original site area. One jar and two undisturbed samples were submitted to the laboratory to represent the foundation materials. One large bag sample from the emergency spillway and eleven large bag samples from the flood plain area were submitted to represent available fill material.

Laboratory tests performed for the dam design include:

(1) Foundation Area.

- a) Atterberg Limits
- b) Sieve Analysis
- c) Dry Unit Weight
- d) One Dimensional Consolidation Test
- e) Permeability
- f) Triaxial Shear Test (CU)

(2) Embankment Materials.

- a) Atterberg Limits
- b) Sieve Analysis

- c) Standard Proctor Test
- d) Triaxial Shear Test (CU)

(3) Stability Loading Conditions.

Stability analyses performed by the SCS for the dam design included consideration of two loading conditions:

- a) Steady Seepage
- b) Full Drawdown

(4) Stability Analysis.

a) Maximum Section at Station 6+25: A slope stability analysis was made on the 2-1/2:1 upstream embankment slope using a modified Swedish circle method. Rapid drawdown from the emergency spillway to the base of the embankment is considered. The embankment will rest on bedrock after normal channel cleanout; therefore, the foundation is considered competent. Strength parameters used for the embankment are $\phi = 10.5^\circ$, $c = 850$ psf. No berms were considered in this analysis and the computed factor of safety is 1.58.

The downstream 2-1/2:1 embankment slope stability analysis considered a full phreatic line (no drain) and a competent foundation. With embankment strength parameters of $\phi = 10.5^\circ$, $c = 850$ psf the computed factor of safety is 1.66.

b) Flood plain Section at Station 6+10: The slope stability analysis of the 2-1/2:1 upstream embankment slope was made using the modified Swedish circle method. Rapid drawdown from the emergency spillway to the base of the embankment is considered. The embankment strength parameters used are $\phi = 10.5^\circ$, $c = 850$ psf. A foundation depth of 11 feet, strength parameters of $\phi = 14.5^\circ$ and $c = 400$ psf were considered and the computed factor of safety is 1.29. No berms were considered in the analysis.

The downstream 2-1/2:1 embankment slope stability analysis considers a full phreatic line (no drain) and an 11-foot depth of foundation. The strength parameters considered are the same as the upstream and the computed factor of safety is 1.29.

(5) Evaluation. The available stability analyses performed by the SCS included the factor of safety for steady seepage and full drawdown loading conditions. Factors of safety for the maximum section were well within the acceptable limits suggested by Appendix D of the guidelines. The flood plain section safety factor is less than the acceptable limits; however, the analysis did not include the berms.

Stability analyses for the partial pool and earthquake loading conditions were not available. The conditions, assumptions, and strength parameters for the full drawdown and steady seepage stability analyses represent a more critical stability condition than for partial pool. The factors of safety determined for the steady seepage and full drawdown loading conditions are about equal to or greater than the suggested factor of safety for the partial pool loading condition.

Stability analyses for the earthquake loading conditions were not available. In accordance with the guidelines, the dam is located within Seismic Zone 1 with a designated seismic coefficient of 0.025 to be used in the conventional equivalent static force method of analysis.

Seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. The design memorandum indicates that near positive cutoff is anticipated and a drain system was not considered necessary for stability of the embankment.

The embankment design provided for a settlement allowance of 1.5 feet. A crest of dam profile survey made as part of the inspection revealed that the anticipated settlement of the embankment has not taken place since construction of the dam.

c. Operating Records. No operational records were available for review by the inspection team.

d. Postconstruction Changes. There have been no post construction changes. Sheet 4 of the "As-Built" drawings shows a 15-inch low level inlet to the drop structure. Sheet 13 of the "As-Built" drawings shows the low level inlet to be 18 inches in diameter. The inspection team was unable to measure the size of this inlet.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. An assesement of the seismic stability is a requirement of the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored, corrected, and/or controlled. These are erosion at the downstream toe of slope and at both abutment/embankment interfaces, the wet area downstream of the dam, the growth of trees on the embankment, animal burrows in the embankment, irregularities in the downstream slope, vehicle tracks on the crest of the dam, and the inoperable slide gate. Seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. The conclusions in this report were based only on performance history and visual conditions and the available engineering design data. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principals and conservatism should pose no serious stability problems during earthquakes in this zone. However, an assessment of the seismic stability is required by the guidelines.

7.2 REMEDIAL MEASURES

a. Alternatives. The spillway capacity and/or height of the dam would need to be increased or the lake level would need to be permanently lowered to increase available flood storage in order to pass the spillway design flood.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) The irregularities in the downstream slope should be monitored. If they become larger, grazing of cattle on the dam should be stopped or reduced. Should the irregularities continue to worsen, the condition should be evaluated by an engineer.

(2) The wet area below the dam noted during the visual inspection should be closely monitored during dry periods to determine if it is dam related. If it is determined to be due to seepage, it should be monitored and documented regularly and any significant changes should be evaluated.

(3) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed.

(4) The erosion gullies at the downstream toe of slope and at the interface of the embankment and the right and left abutments should be backfilled with suitable material and compacted. Paved ditches, riprap, or other slope protection may be required to control the concentrated runoff.

(5) The animal burrows in the embankment should be corrected since they can lead to piping. Control measures should be implemented under the direction of a qualified engineer to discourage increased animal activity in the area. The embankment slope should be monitored during this repair.

(6) The slide gate for the low level inlet to the drop structure of the principal spillway should be repaired and maintained in working condition.

(7) Seepage analyses should be performed and made a matter of record.

(8) A detailed inspection of the dam should be made periodically. The results should be recorded and made a matter of record. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

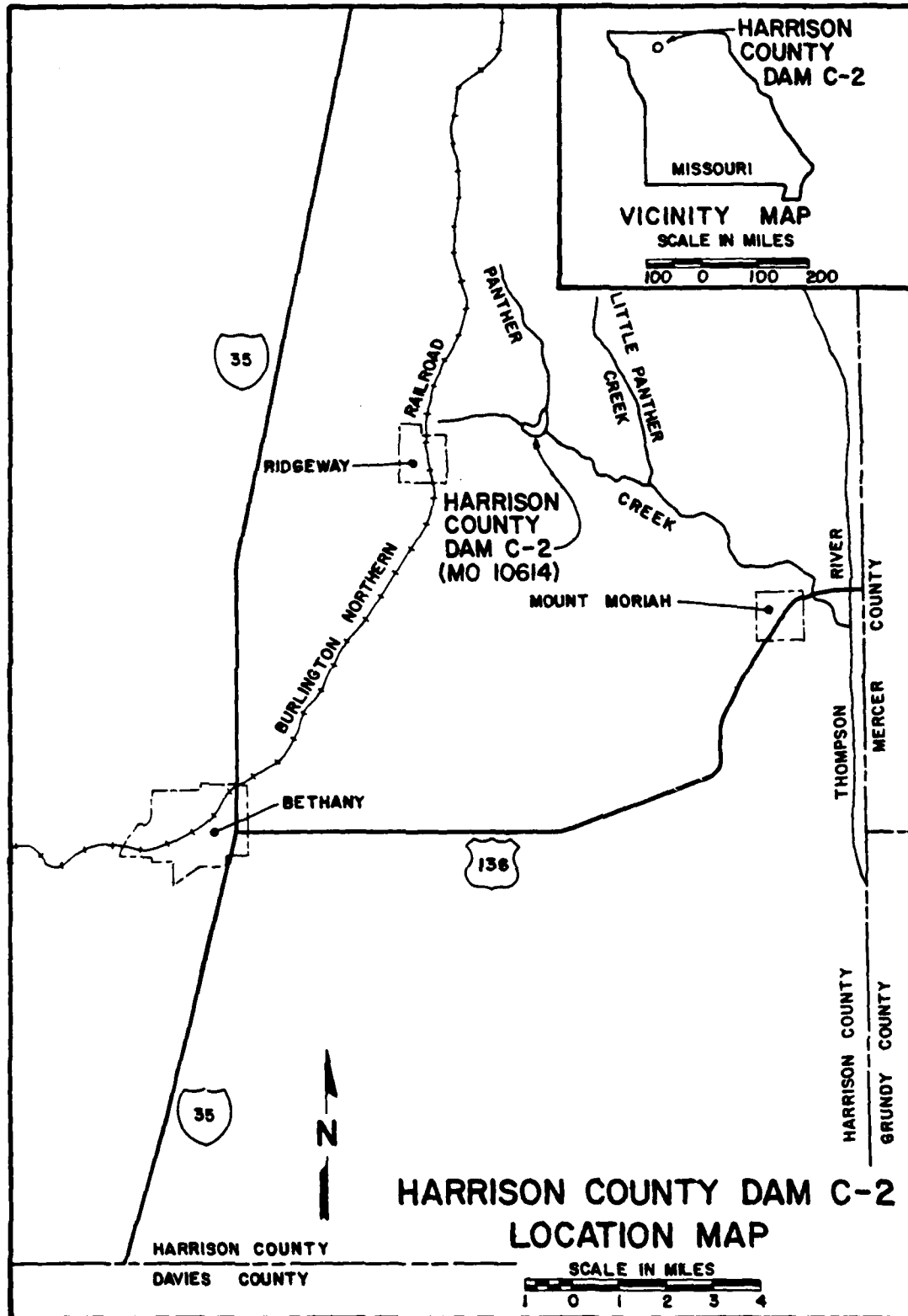
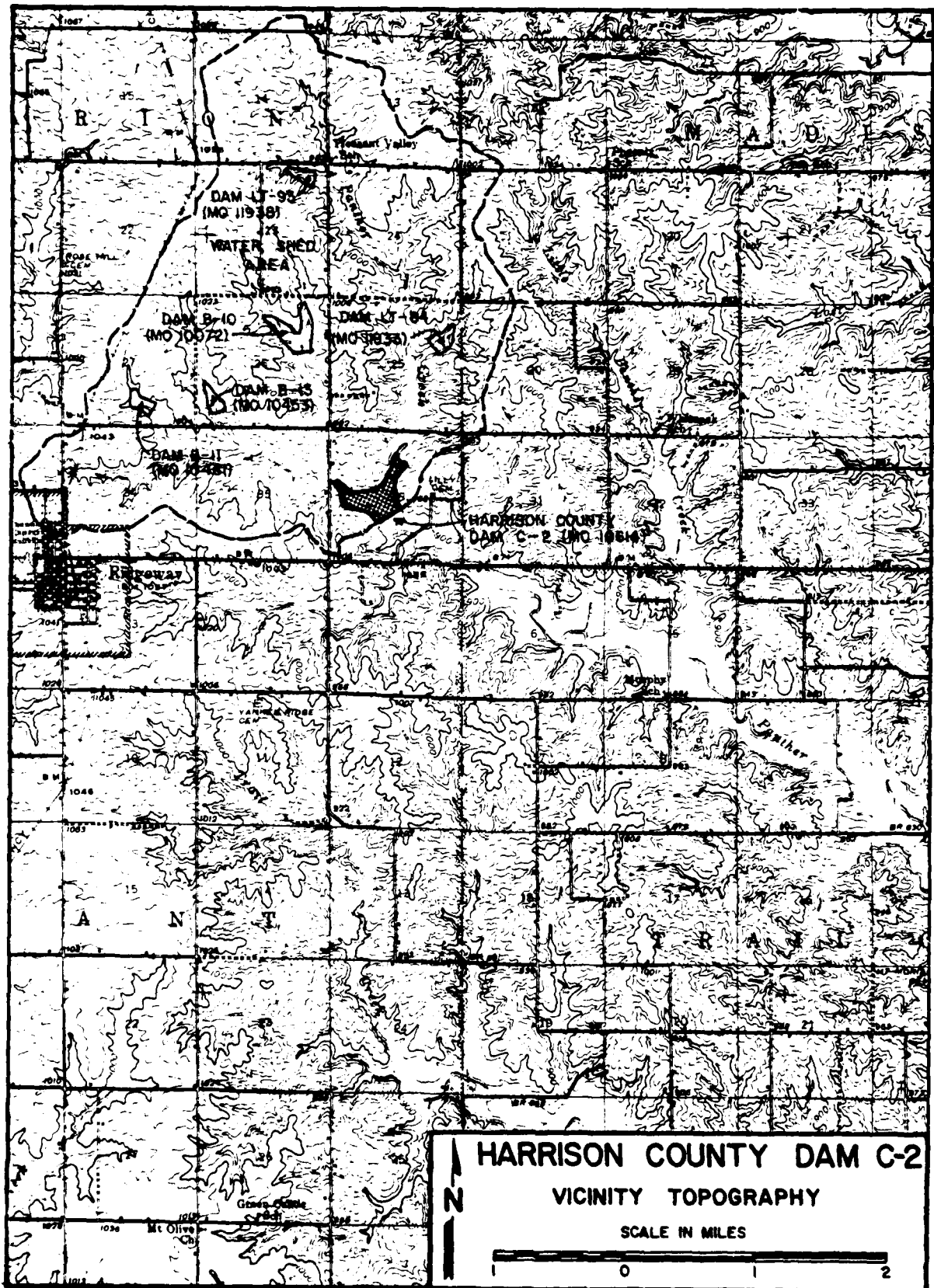
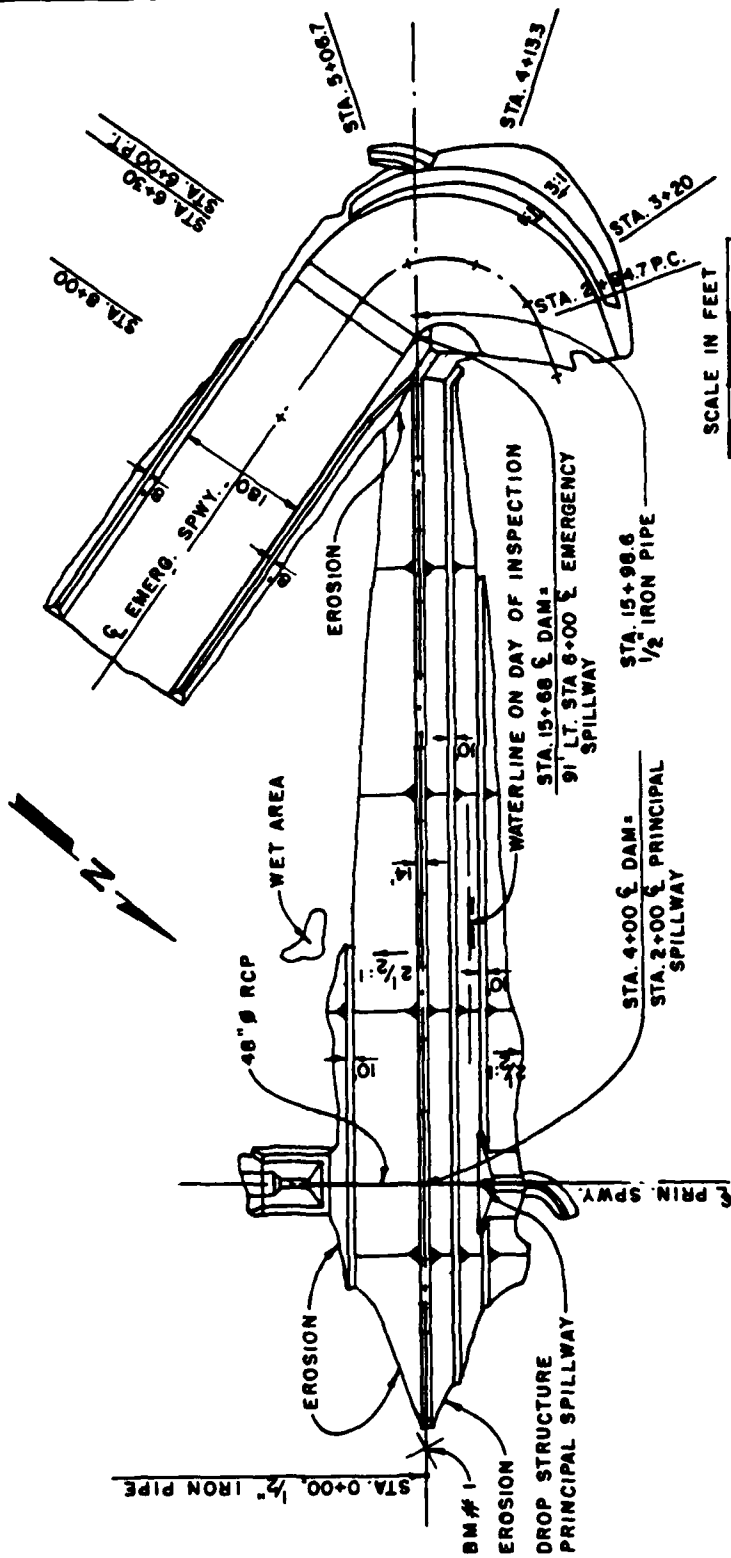


PLATE 1



BM #1 ELEV. 930.38 TOP OF BRASS CAP
IN CONCRETE POST STAMPED "SCS STA 0+40
EL. 930.38" LOCATED $\frac{1}{2}$ FILL NEAR $\frac{1}{2}$ GATE.



NOTE:
DAM PLAN FROM
"AS-BUILT" DRAWINGS

HARRISON COUNTY DAM C-2 DAM PLAN

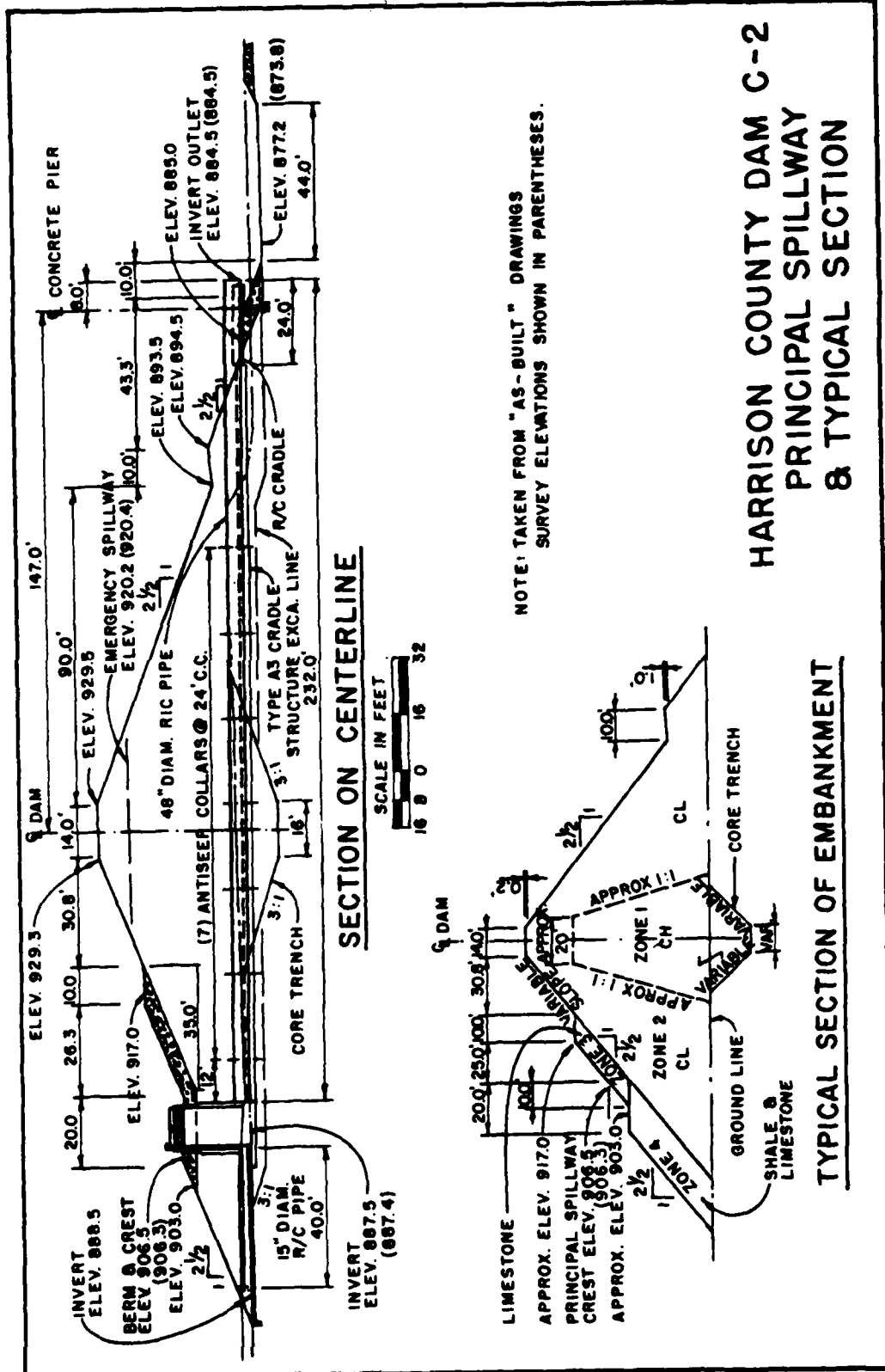
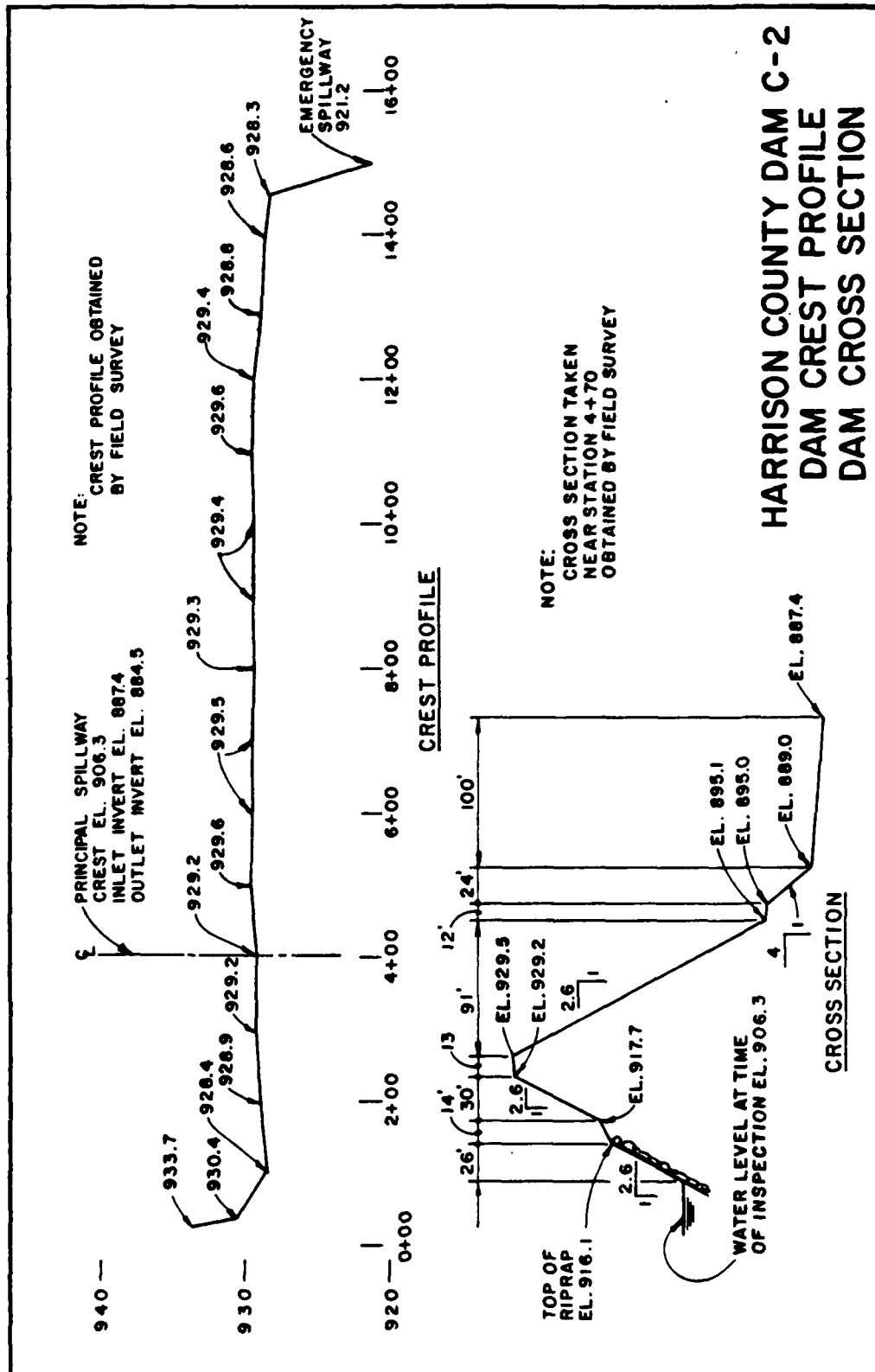
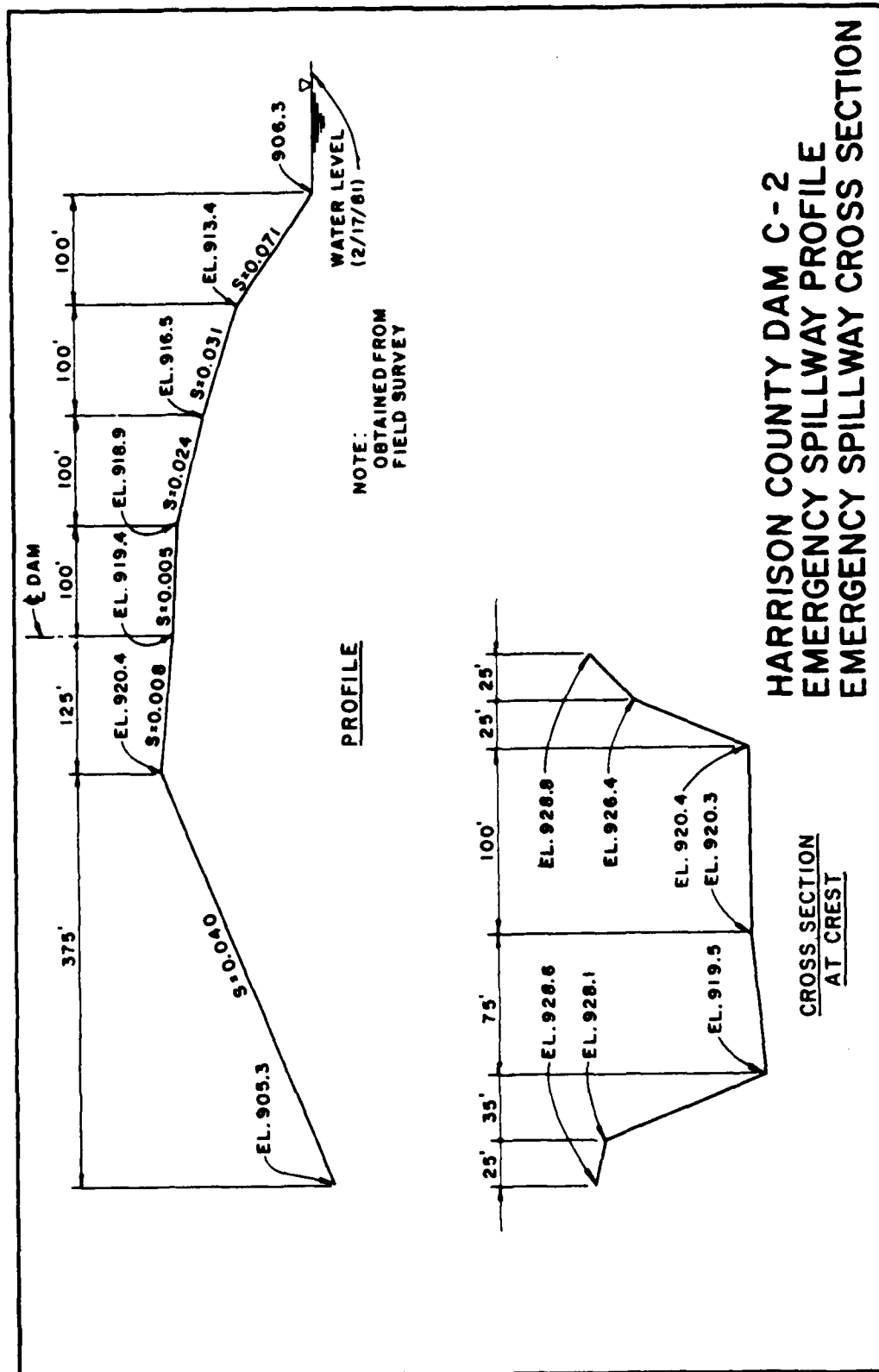
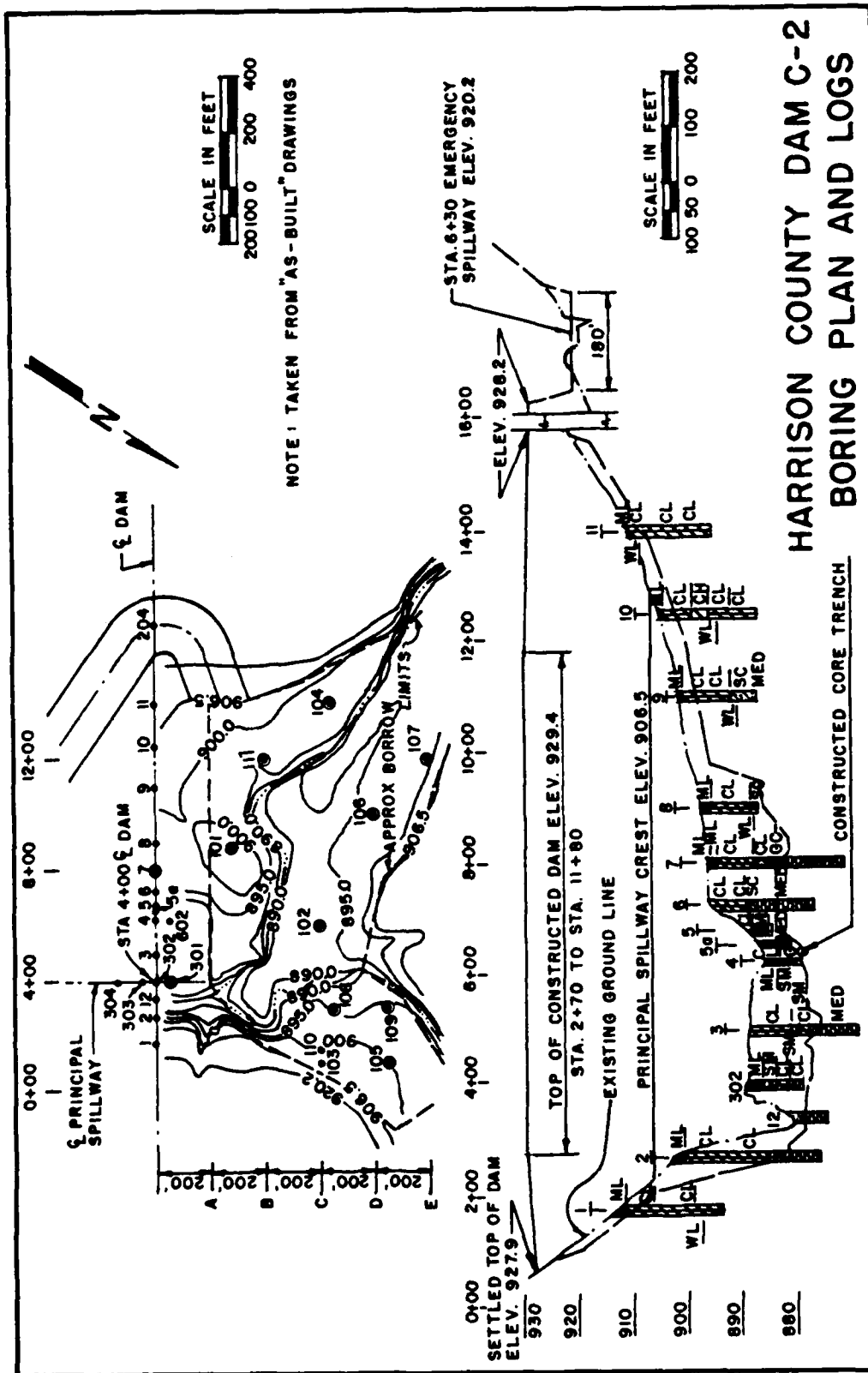


PLATE 4







SCALE IN FEET
200 100 0 200 400

NOTE: TAKEN FROM "AS-BUILT" DRAWINGS

SCALE IN FEET
100 50 0 100 200

HARRISON COUNTY DAM C-2 BORING PLAN AND LOGS

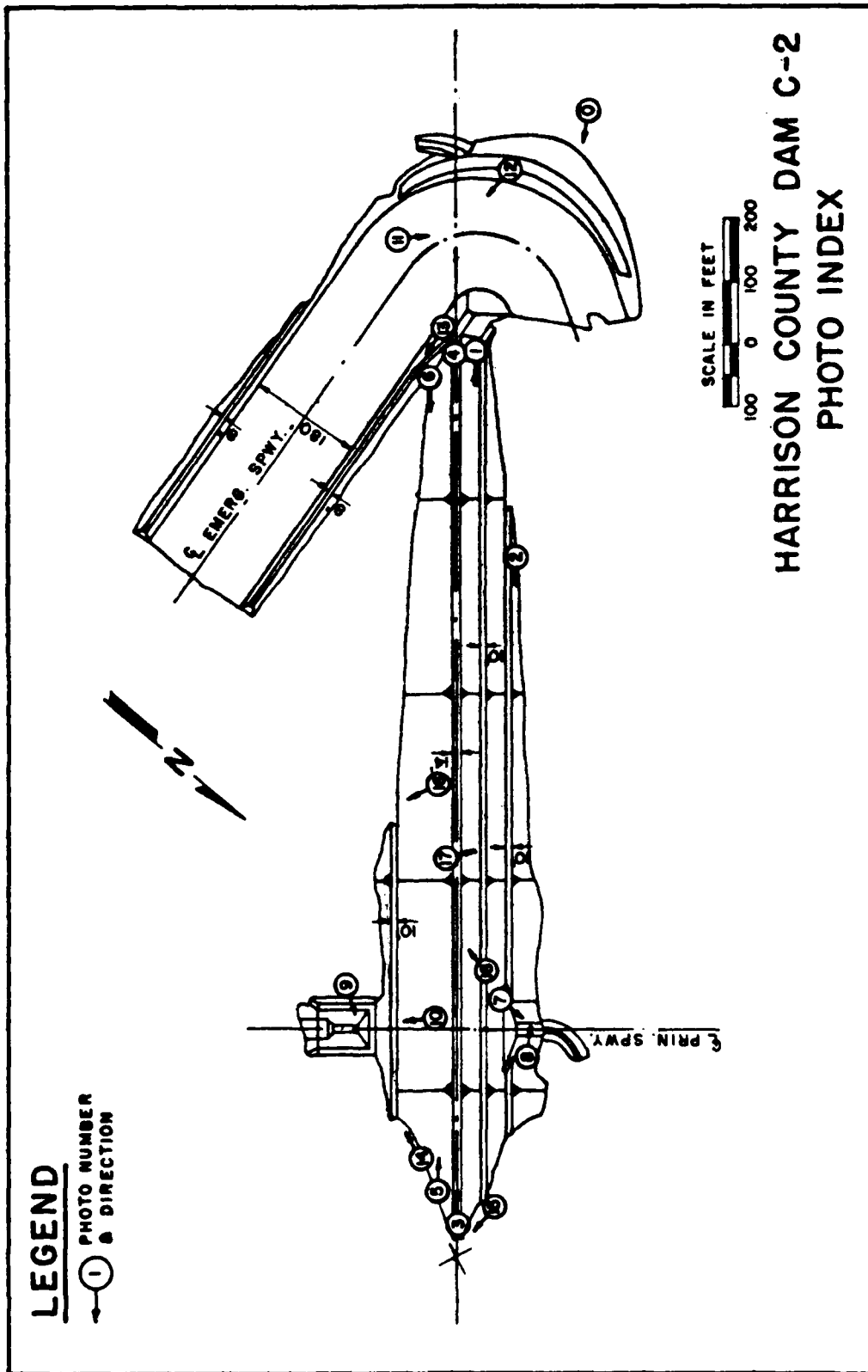


PLATE 8

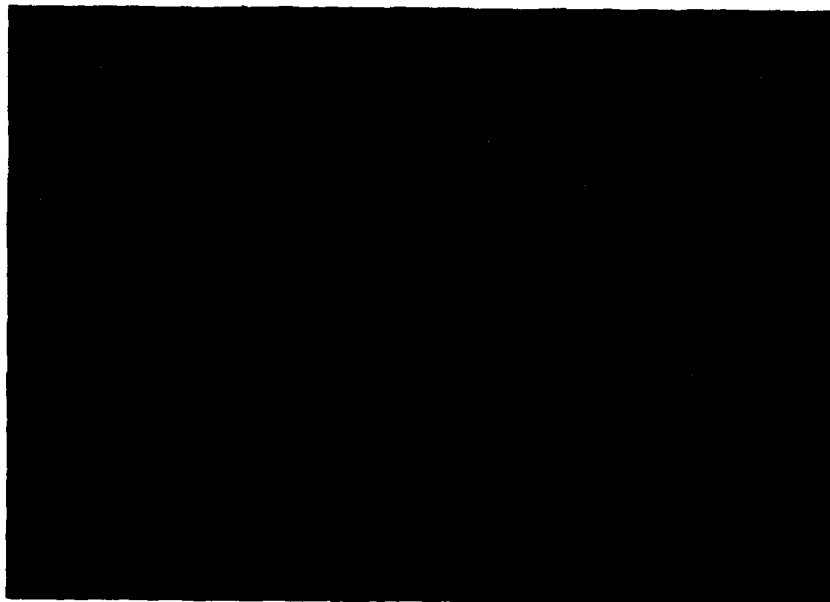


PHOTO 1: UPSTREAM FACE OF DAM



PHOTO 2: UPSTREAM FACE OF DAM AT WATERLINE

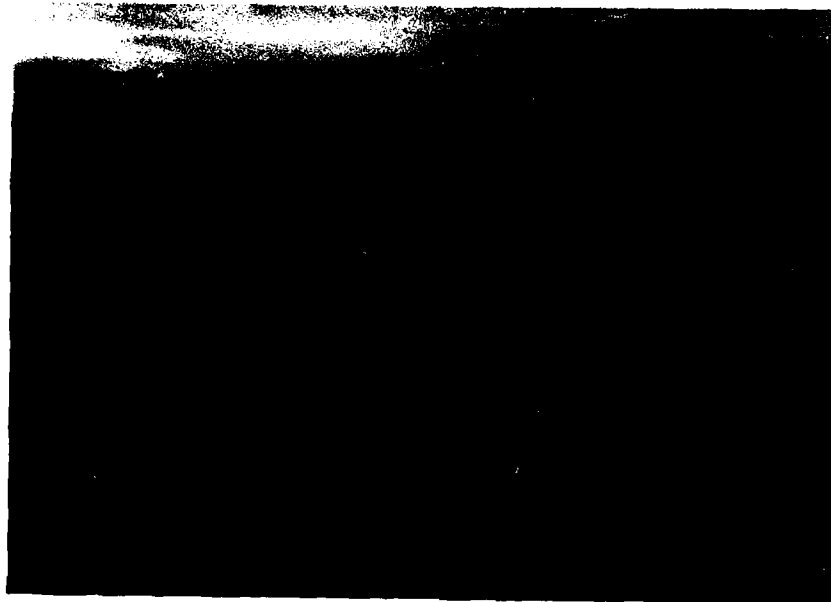


PHOTO 3: CREST OF DAM LOOKING WEST

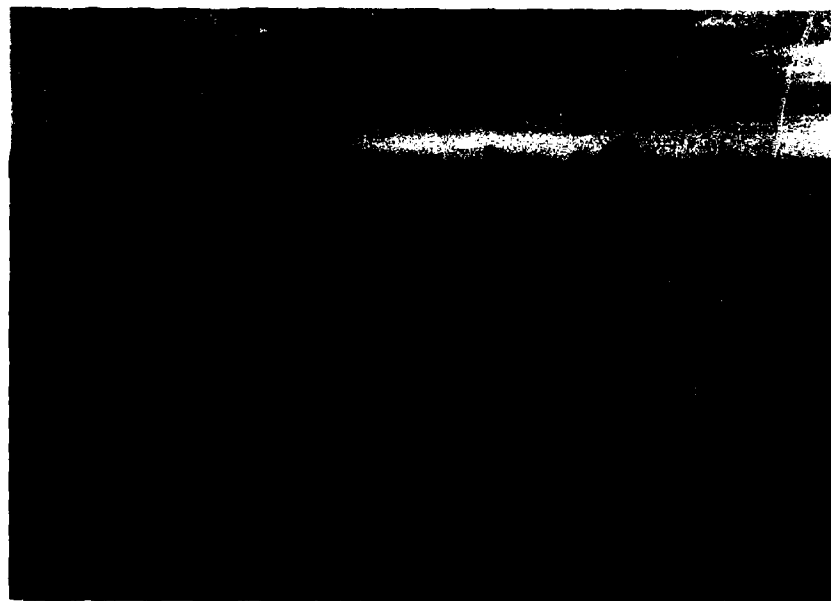


PHOTO 4: CREST OF DAM LOOKING EAST



PHOTO 5: DOWNSTREAM FACE OF DAM LOOKING WEST

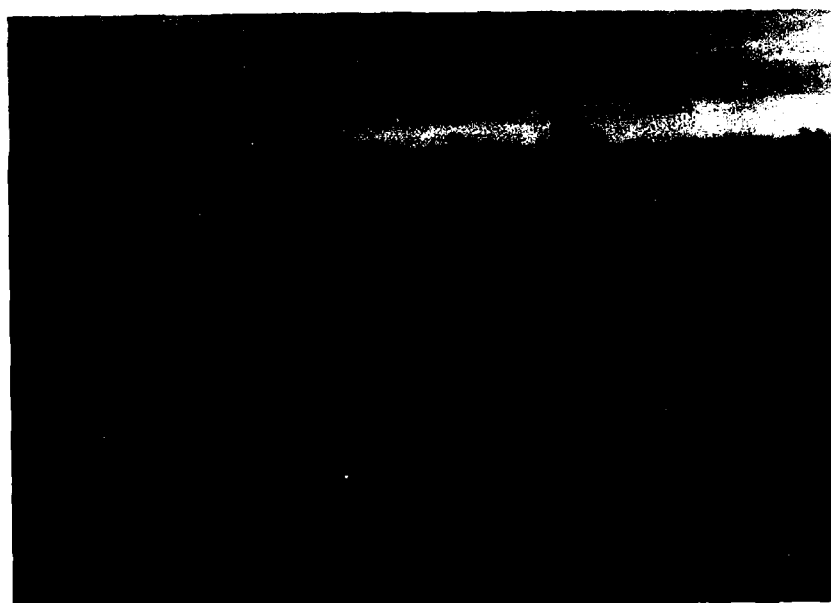


PHOTO 6: DOWNSTREAM FACE OF DAM LOOKING EAST

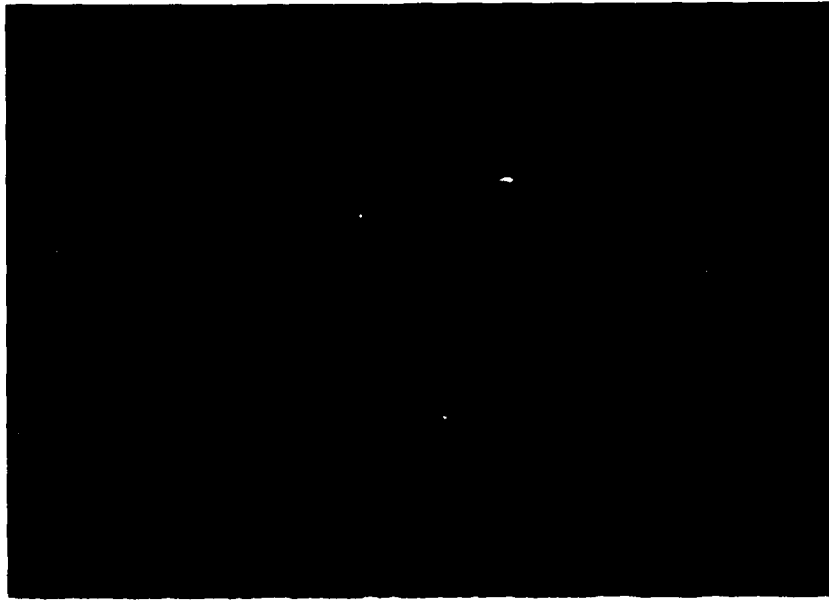


PHOTO 7: PRINCIPAL SPILLWAY DROP INLET STRUCTURE



PHOTO 8: PRINCIPAL SPILLWAY WEIR

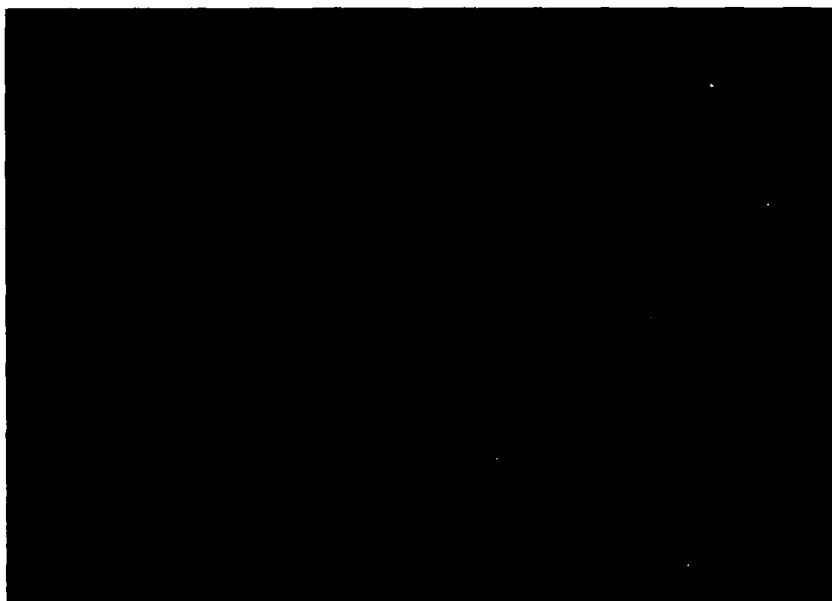


PHOTO 9: PRINCIPAL SPILLWAY PIPE OUTLET

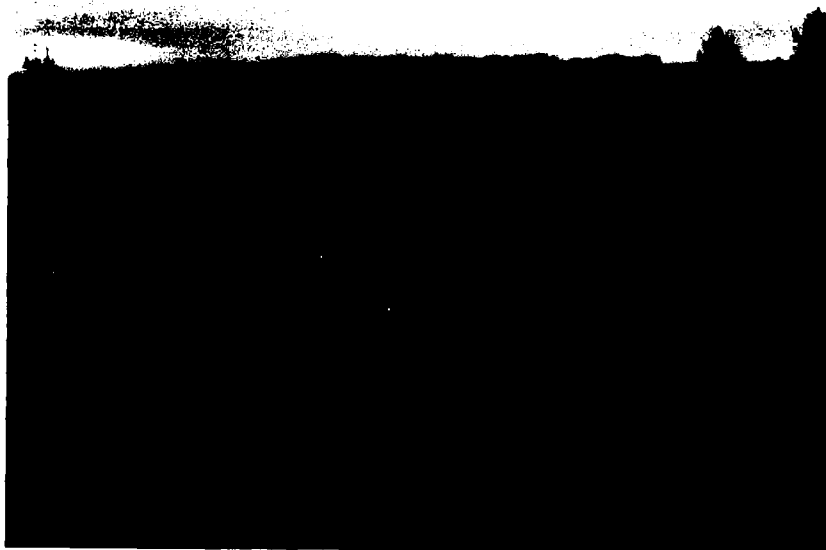


PHOTO 10: CHANNEL DOWNSTREAM OF PRINCIPAL SPILLWAY

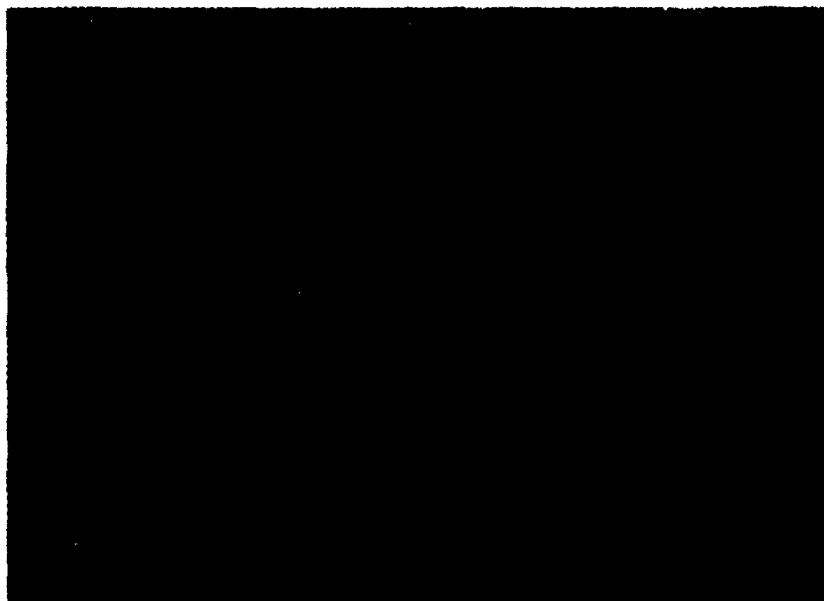


PHOTO 11: EMERGENCY SPILLWAY LOOKING UPSTREAM



PHOTO 12: EMERGENCY SPILLWAY LOOKING DOWNSTREAM



PHOTO 13: DIKE ALONG LEFT BANK OF EMERGENCY SPILLWAY

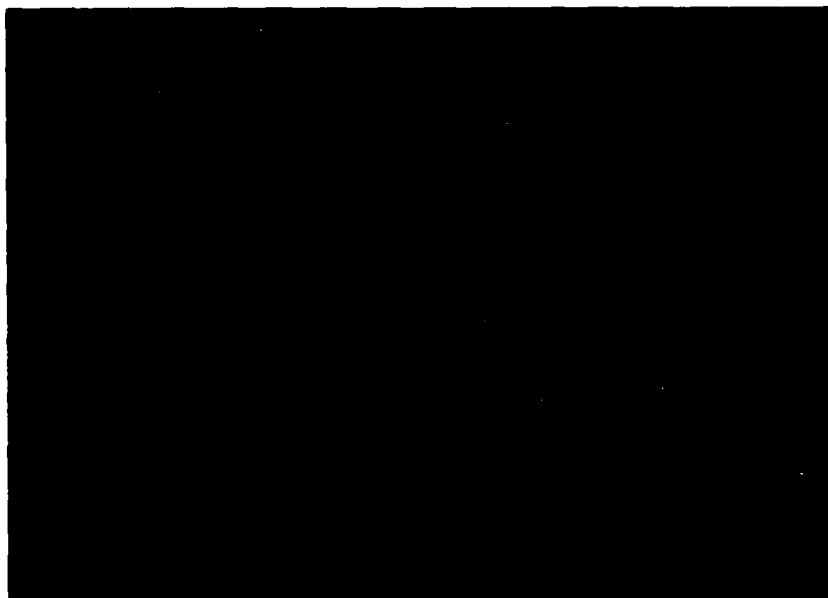


PHOTO 14: EROSION AT TOE OF DOWNSTREAM FACE OF DAM

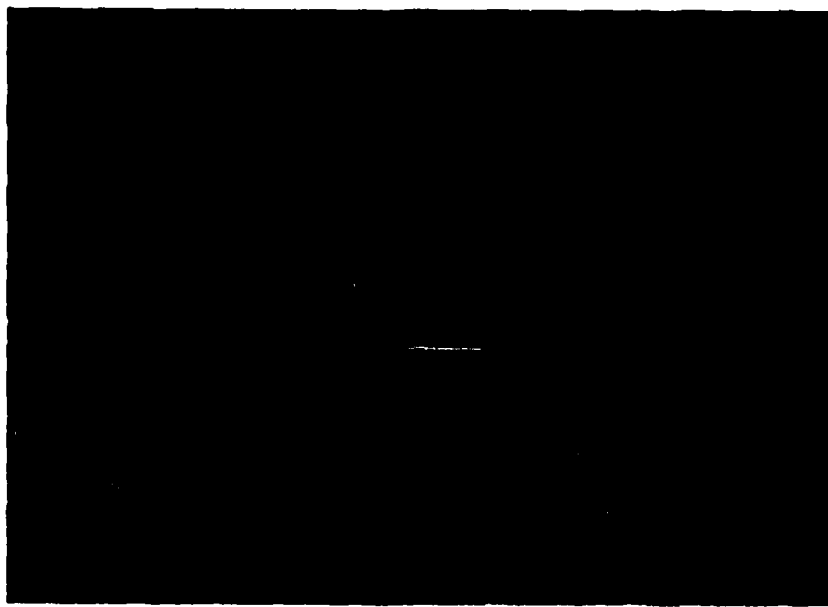


PHOTO 15: EROSION AT LEFT ABUTMENT - UPSTREAM FACE OF DAM



PHOTO16: DRAINAGE DITCH DOWNSTREAM OF DAM

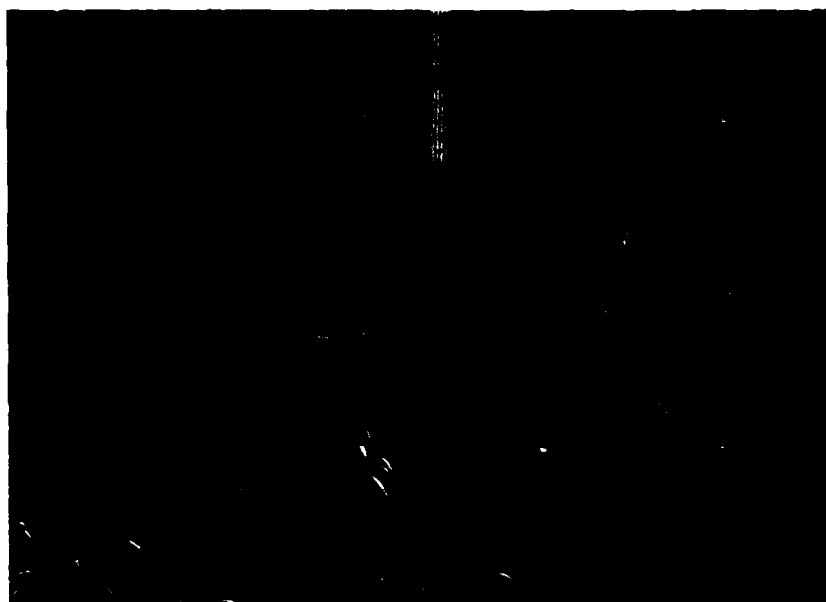


PHOTO 17: ANIMAL BURROW NEAR CREST OF DAM



PHOTO 18: ANIMAL BURROW ON UPSTREAM FACE OF DAM

APPENDIX A
HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrographs for Harrison County Dam C-2 and five upstream reservoirs, Harrison County Dam B-11, Harrison County Dam B-13, Harrison County Dam B-10, Tugglet's Dam LT-93, and Meek's Dam LT-84. The inflow hydrographs were then routed through the reservoirs and spillways. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33) (2). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411 (3). Comparison of the routings of the PMP storm ratios with the total rainfall of a 24 hour, one percent chance probability storm indicates that the one percent chance flood will not cause overtopping of Harrison County Dam C-2.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method (1, 4). The parameters for the unit hydrograph are shown in Table 1. The lag and time of concentration for each watershed were obtained from SCS design data and were verified using the Kirpich and Snyder methods.

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

Storms were routed through the six reservoirs noted above.

Routing through the reservoirs was performed using the modified Puls Method. The initial reservoir pool elevations for the routing of each storm were determined to be equivalent to the crest elevations of the principal spillways in accordance with antecedent storm conditions preceding the probable maximum storm outlined by the U.S. Army Corps of Engineers, St. Louis District (5). The hydraulic capacity of the spillways and the storage capacity of the reservoirs were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curves for the spillways are shown in Table 4. The flow over the crests of the dams was determined using either the non-level dam crest option (\$L and \$V cards) or the weir flow option of the HEC-1 program. The program assumes critical flow over a broad-crested weir in the non-level dam crest option.

Breach analyses were performed using HEC-1 for reservoirs upstream of Harrison County Dam C-2 with spillway capacities less than 50 percent of the PMF. The breaching parameters are shown in Table 5.

The result of the routing analysis indicates that 40 percent of the Probable Maximum Flood (PMF) will not overtop Harrison County Dam C-2.

A summary of the routing analysis for different ratios of the PMF is shown in Table 6.

The computer input data and a summary of the output data are presented at the back of this appendix.

"As-Built" drawings and hydrologic/hydraulic design data for Harrison County Dam C-2 and the upstream reservoirs were made available by the SCS, Columbia, Missouri.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:	Harrison County Dam B-10	Harrison County Dam B-11	Harrison County Dam B-13	Meek's Dam LT-84	Tuggett's Dam LT-93	Harrison ⁴ County Dam C-2 East Arm West Arm
	1.01 sq. mi. 0.32 hour	0.32 sq. mi. 0.19 hour	0.76 sq. mi. 0.32 hour	0.39 sq. mi. 0.22 hour	0.36 sq. mi. 0.20 hour	3.52 sq. mi. 2.76 sq. mi.
Drainage Area (A) ¹						
Lag Time (L _g)	0.32 hour	0.19 hour	0.32 hour	0.22 hour	0.20 hour	1.33 hour 0.68 hour
Time of concentration (T _c)	0.53 hour ²	0.31 hour ²	0.54 hour ²	0.37 hour ³	0.34 hour ³	2.21 hour ² 1.14 hour ³
Duration (D)	4.2 minutes	2.5 minutes	4.3 minutes	3.0 minutes	2.7 minutes	17.7 minutes 9.0 minutes
(Use 5 minutes in each case for the duration)						

NOTES:

- 1 - Incremental drainage areas. Total drainage area for Harrison County Dam C-2 is 9.11 square miles.
- 2 - Obtained from SCS design data. These values are comparable to those calculated using the Kirpich method.
- 3 - Calculated using the Kirpich method.
- 4 - The portion of the Harrison County Dam C-2 drainage area below the upstream reservoirs was divided into the east and west arm for performing the hydrologic analyses.

Unit Hydrograph Ordinates
Discharge (cfs)*

	Harrison County Dam B-10	Harrison County Dam B-11	Harrison County Dam B-13	Meek's Dam LT-84
<u>Time (Min.)*</u>				
0	0	0	0	0
5	174	182	125	147
10	556	579	400	502
15	1,098	670	795	706
20	1,342	484	993	630
25	1,291	252	968	419
30	1,065	141	807	239
35	728	77	567	146
40	484	43	377	87
45	337	24	262	52
50	232	13	184	31
55	159	7	126	19
60	108	4	87	11
65	73	2	59	7
70	51	0	41	4
75	35		28	2
80	24		20	0
85	17		14	
90	12		10	
95	8		7	
100	5		4	
105	2		2	
110	0		0	

* From HEC-1 computer output

FORMULAS USED:

$$T_c = (11.9 \times L^3/H)^{0.385} (6)$$

$$L_g = 0.6 T_c$$

$$D = 0.133 T_c$$

Unit Hydrograph Ordinates
Discharge (cfs)*
 (Continued)

<u>Time (Min.)*</u>	Tugglet's Dam LT-93	Harrison County Dam C-2	
		East Arm	West Arm
0	0	0	0
5	167	23	74
10	554	56	232
15	704	109	446
20	575	173	743
25	327	243	1,121
30	188	334	1,472
35	109	438	1,710
40	63	559	1,819
45	36	698	1,828
50	21	839	1,763
55	12	960	1,623
60	7	1,062	1,463
65	4	1,145	1,260
70	2	1,195	1,013
75	0	1,232	815
80		1,239	674
85		1,238	557
90		1,231	469
95		1,187	392
100		1,139	326
105		1,086	265
110		1,028	223
115		967	185
120		892	153
125		810	127
130		719	104
135		640	87
140		566	72
145		513	60
150		464	50
155		418	41
160		379	34
165		343	28
170		315	24
175		288	20
180		260	17
.		.	.
.		.	.
410		0	0

TABLE 2
RAINFALL-RUNOFF VALUES

<u>Selected Storm Event</u>	<u>Storm Duration (Hours)</u>	<u>Rainfall (Inches)</u>	<u>Runoff (Inches)</u>	<u>Loss (Inches)</u>
PMP				
Harrison County Dam B-10	24	31.07	29.91	1.16
Harrison County Dam B-11	24	31.07	29.78	1.29
Harrison County Dam B-13	24	31.07	29.78	1.29
Meek's Dam LT-84	24	31.07	29.78	1.29
Tugglet's Dam LT-93	24	31.07	29.78	1.29
Harrison County Dam C-2				
East Arm	24	31.07	29.78	1.29
West Arm	24	31.07	29.78	1.29

Additional Data:

SCS Runoff Curve Number (CN)

	AMC II ¹	AMC III ²
Harrison County Dam B-10	79	91
Harrison County Dam B-11	78	90
Harrison County Dam B-13	78	90
Meek's Dam LT-84	78	90
Tugglet's Dam LT-93	78	90
Harrison County Dam C-2	78	90

¹ Obtained from SCS "As-Built" data

² Used for PMF runoff hydrograph calculations

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
Harrison County			
Dam B-10			
*122.0 ¹	19.2	128	0
**126.8	29.0	243	80
***129.1	35.7	318	498
Harrison County			
Dam B-11			
*80.0 ¹	3.9	19	0
**84.0	6.9	40.6	40
***86.8	9.5	65	268
Harrison County			
Dam B-13			
*112.0 ¹	11.6	93	0
**116.4	18.5	160	77
***118.7	28.8	214	780
Meek's Dam			
LT-84			
*94.0 ¹	6	27	0
**96.9	9.9	48.7	5
***101.0	10.5	89	1,048
Tugglet's Dam			
LT-93			
*95.0 ¹	5	25	0
**98.0	7.5	40	11
***101.3	10.3	88	478
Harrison County			
Dam C-2			
*906.3 ²	67	424	0
**920.4	161	2,079	362
***928.3	471	3,963	11,791

*Principal spillway inlet crest elevation

**Emergency spillway crest elevation

***Top of dam elevation

The relationships in Table 3 were developed from the SCS "As-Built" data and the field measurements.

¹ Elevation based on arbitrary datum for specific site

² Elevation in feet m.s.l.

TABLE 4
SPILLWAY RATING CURVE

<u>Reservoir Elevation</u>	<u>Principal Spillway Discharge (cfs)</u>	<u>Emergency Spillway Discharge (cfs)</u>	<u>Total Spillway Discharges (cfs)</u>
Harrison County			
Dam B-10			
*122.0 ¹	0	0	0
122.5	73	0	73
**126.8	80	0	80
127.8	80	100	180
***129.1	81	417	498
131.8	81	1,700	1,781
Harrison County			
Dam B-11			
*80.0 ¹	0	0	0
82.0	12	0	12
**84.0	40	0	40
85.0	41	15	56
***86.8	44	224	268
89.0	48	970	1,018
Harrison County			
Dam B-13			
*112.0 ¹	0	0	0
114.5	63	0	63
**116.4	77	0	77
117.5	79	222	301
***118.7	81	699	780
120.6	84	1,820	1,904
Meek's Dam LT-84			
*94.0 ¹	0	0	0
95.0	2	0	2
**96.9	5	0	5
98.9	7	314	321
***101.0	8	1,040	1,048
103.9	9	2,680	2,689

TABLE 4
SPILLWAY RATING CURVE
(Continued)

<u>Reservoir Elevation</u>	<u>Principal Spillway Discharge (cfs)</u>	<u>Emergency Spillway Discharge (cfs)</u>	<u>Total Spillway Discharges (cfs)</u>
Tugget's Dam LT-93			
*95.0 ¹	0	0	0
96.0	3	0	3
**98.0	11	0	11
100.0	15	193	208
***101.3	18	460	478
103.0	20	985	1,005
Harrison County Dam C-2			
*906.3 ²	0	0	0
910.3	299	0	299
**920.4	362	0	362
924.4	384	3,616	4,000
***928.3	404	11,387	11,791
931.0	420	18,600	19,020

*Principal spillway crest elevation

**Emergency spillway crest elevation

***Top of dam elevation

¹ Elevation based on arbitrary datum for specific site

² Elevation in feet m.s.l.

METHOD USED:

Principal spillway release rates were determined from SCS "As-Built" data which utilized the weir flow and pipe flow equations.

Emergency spillway releases were determined from the SCS "As-Built" data and SCS Technical Release No. 39⁽⁷⁾.

TABLE 5

BREACHING PARAMETERS

	Harrison County Dam B-10	Harrison County Dam B-11	Harrison County Dam B-13	Meek's Dam LT-84	Tugget's Dam LT-93
Bottom Width of Breach (BRWID)	10.0 feet	10.0 feet	10.0 feet	10.0 feet	10.0 feet
Side Slope of Breach (z) (In feet horizontal to 1.0 feet vertical)	0.5	0.5	0.5	0.5	0.5
Elevation of Breach Bottom at Maximum Size of Breach (ELBM)	108.0 feet	68.0 feet	92.0 feet	85.0 feet	83.0 feet
Time for Breach to Develop to Maximum Size (TFAIL)	1.0 hour	1.0 hour	1.0 hour	1.0 hour	1.0 hour
Elevation of Water Surface Which Will Cause Dam to Fail (FAILEL)	129.10 feet	86.8 feet	118.7 feet	101.0 feet	101.3 feet

TABLE 6

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam	Duration of Overtopping (Hours)
-	0	*906.3	424	0	-	-
0.40	22,087	927.9	3,789	10,880	0	-
0.45	23,286	928.5	4,037	12,165	0.2	1.1
0.50	25,458	929.0	4,252	13,345	0.7	2.1
1.00	43,125	931.6	5,338	36,810	3.3	4.8

* Principal spillway crest elevation

BIBLIOGRAPHY

- (1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Modification April 1980, Davis, California.
- (2) HMR 33, Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours, U.S. Department of Commerce, NOAA, National Weather Service, 1956.
- (3) U.S. Department of the Army, Corps of Engineers, Standard Project Flood Determinations, Civil Engineer Bulletin No. 52-8, EM 1110-2-1411, Revised 1965, Washington, D.C.
- (4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.
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- (8) U.S. Department of the Interior, Geological Survey, Techniques of Water Resources Investigations of the United States Geological Survey, Chapter A5, 1967.
- (9) U.S. Department of Agriculture, Soil Conservation Service, Soil Interpretations Record, 1979.

APPENDIX B
GEOLOGIC INVESTIGATION
&
DESIGN MEMORANDUM

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Missouri County Harrison k. 36 Sec. 36 T 65N R 27W Watershed Panther Creek
Subwatershed WP-08-5 Fund class WP-1, etc. Site number C-2 Site group I Structure class a
Investigated by Nuel E. Johnson Equipment used Feiling 1500 Date 12-13-67
(signature and title) Geologist (Type, size, make, model, etc.)

SITE DATA

Drainage area size 9.1 sq. mi., 5831 acres. Type of structure D.I. concrete Purpose Floodwater
Direction of valley trend (downstream) SE Maximum height of fill 45.8 feet. Length of fill 1450 feet.
Estimated volume of compacted fill required 172,000 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
<u>7</u> Sediment	<u>476</u>	<u>67.5</u>	<u>25.6</u>
Floodwater	<u>1515</u>	<u>160</u>	<u>39.2</u>

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Dissected Till Plain Topography Rolling Attitude of beds: Dip 0 Strike —
Steepness of abutments: Left 23 percent; Right 9 percent. Width of floodplain at centerline of dam 300 feet
General geology of site: The site is located in National Soil Resource Area 109, the Iowa & Missouri Till Plain. The Kansan till occurs on the slopes & ridges with modern alluvium and terrace level alluvium occurring in the valley floor. Kansan till in the area is classified as a stiff cl, coarse material is predominately sand and fine gravel with few glacial rocks larger than cobbles. The stream channel has cut into and is now held by the underlying Winterset limestone which is a member of the Dennis Formation, Kansas City Group, Pennsylvanian System. The site is located in an area devoted to pasture & meadow. Timber occurs mostly adjacent to the stream channel and other drainage ways

C-2
Panther Creek
DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FORM SCS-3768
REV. 2-64
SHEET 2 OF 5

FEATURE 8 Dam, Principal Spillway, Emergency Spillway, Stream Channel, Drainage, Barrow
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
	EXPLORATION	SAMPLING	UNDISTURBED (STATE TYPE)	LARGE DISTURBED	SMALL DISTURBED
6" Slat Auger	31 27	12	2 She/b4	12 Bag	1 Jar
NX Core	6				
NX Core, pressure test	3				
TOTAL	40 30	12	2	12	1

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

The left abutment is stiff glacial Till. Bedrock occurred in Test Hole #2 at 17.6 feet, elevation 975.4. Pressure tests were made in the rock without water loss. The right abutment is also till, however, bedrock was not encountered in test holes #10 & #11. The bedrock of the valley floor has a rather uniform surface at approximate elevation 889.0. The overlying alluvium ranges in depth from 6 to 10 feet. An apparent old channel occurs on the right side as shown by Test Hole #4, station 6+25. Material in the lower part is classified SM and SC. Similar conditions were found 50 feet upstream and 35 feet downstream. The surface alluvium is classified CL except for the material adjacent to the channel in TH #302 which was classified MH. A stratum of coarser material classified SM occurs about 1 foot above the contact of the bedrock. This stratum is continuous and believed permeable. A rock core was taken in TH #3. Rock occurred at 9.5' and was penetrated 4 ft with the slat auger. The upper 2 feet of core appeared weathered and broken. The remaining core was unweathered and sound rock. The gentle slope from station 7+00 to approximately 13+00 is classified as stiff CL Terrace alluvium. Test holes

DRILLING PROGRAM

[illegible]

6, 7, 8, & 9 were bottomed in bedrock or carried to refusal. Rock core was taken in Test hole #6 and pressure test of the bedrock were made without water loss. Alluvium underlain with limestone at a relatively uniform elevation forms the foundation of the principal spillway. The alluvium is similar to the alluvium on the E of Dam and is 10 to 12 feet deep. The pier location is in the channel and on bedrock. A core was taken from this test hole. Bedrock occurs at shallow depths on the centerline of the emergency spillway. The overburden is classified as stiff Ch glacial till or residuum. The underlying bed rock is mostly limestone with interbedded thin shale beds with lesser amounts of shale. The depth of weathering in the bedrock is approximately 3 to 7 feet. The underlying sound rock is thin to medium bedded limestone with interbedded gray shale. Barrow will be Terrace level alluvium classified stiff Ch and alluvium classified Mh and Ch. There is sufficient barrow available below the crest elevation of the principal spillway. Bedrock occurs at shallow depth in the stream channel or the channel is on bedrock. Channel deposits are seasonal and change frequently.

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Missouri County Harrison Watershed Panther Creek Subwatershed _____
Site number C-2 Site group I Structure class 9 Investigated by Donald B. Edwards Date 12-13-67
(signature of Geologist)

INTERPRETATIONS AND CONCLUSIONS

The weakest material in the embankment foundation appeared to be the alluvium of the valley floor. Samples were taken from TH 301, & principal spillway 1+50 was being most representative of the material classified CL & SM. The alluvial material classified ML on the surface is confined to the area immediately adjacent to the right side of the channel and limited in extent. The old channel on the right side of the floodplain between & stations 6+00 and 6+40 appears to extend the width of the foundation. The material to the right of station 6+50 is classified mostly a stiff CL and occurs as terrace level alluvium, till or residuum. The underlying coarse material in test holes 6, 7, 8 & 9 is classified SC & GC and believed not permeable. The GC material in TH #7 was sampled for laboratory classification. Several pressure tests were made in the bedrock with no unfavorable results were in the upper part of the limestone which was classified as weathered. At the proposed location of the principal spillway the alluvium varies somewhat in texture but the depth and the elevation of the underlying bedrock is generally uniform. The overburden of the emergency spillway was sampled for borrow and is representative of material which will not contain broken or weathered rock fragments. The depth of weathering of the bedrock is variable due to the different thickness and sequence of the shale and limestone beds and which was exposed to weathering. This was discussed with the project engineer and estimates were made on how much of the weathered rock could be classed as common excavation and are indicated on the engineers field design prints of the geology sheets. The underlying or unweathered rock will stand on a vertical cut.

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Missouri County Harrison Watershed Butter Creek Subwatershed _____
Site number C-2 Site group _____ Structure class _____ Investigated by David E. Edwards Date _____
(signature and title)
Geologist

INTERPRETATIONS AND CONCLUSIONS

There is sufficient Borrow available below the crest elevation of the principal spillway. However, a higher water level in the alluvial areas at construction will increase haul distance.

Estimated cu/yds of compacted fill available.

Borrow Hole	cu/yds
101	19,200
102, 104, 106, 109	30,000 per ft depth
103	3,600
107	19,200
105, 108	27,800
Emergency Spillway	16,500 common
	7,500 Rock

Engineer's Report - Investigation of Dam site - Structure C-2, Panther Creek

Harold Townsend 12-13-67

CORE TRENCH: Recommended depths

Station	Elevations
1+00	920.0
2+40	902.0
3+10	878.0
5+00	876.5
6+50	876.5
7+30	883.5
8+00	882.0
9+00	885.0
9+50	895.0
12+00	900.0
14+00	907.0
15+60	917.0

3:1 slopes at both end of the core trench.

The recommended core trench depths will remove the weathered limestone or be in good CL material and should provide a positive core cutoff. Foundation drainage will not be needed to relief seepage through the foundation or embankment.

Rock excavation is not anticipated. Only material that is weathered and can be ripped will ~~be~~ need to be removed. This material will need to be wasted.

EMERGENCY SPILLWAY: Limestone was encountered in the inlet channel to the emergency spillway. Some of the overburden will be suitable for fill and should be classed as borrow. The weather limestone, shale and material with rock fragments too large for fill material should be classed as excavation common and wasted. This material should be wasted along the upstream toe of the dam in the deeper fill sections. Preliminary estimates indicate that there will be about 2500 cu yds of rock excavation. A zone fill is recommended so the rock excavation material utilized. This zone of rock fill should oh on the upstream face in the area of anticipated wave action.

STREAM CHANNEL CLEAN OUT: Excavation in the stream channel is recommended from the core trench to the upstream toe of the dam. The extent and depth will be indicated on the field design prints of the geology sheets.

BORROW: Adequate fill material will be available from the emergency spillway and the sediment pool areas. A wet construction period will limit depth of borrow in the sediment pool and lengthen the haul distance.

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SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

9CS-3337
REV. 2-64

WATERSHED Panther Creek SUB-WATERSHED C-2
 LOCATION Harrison Co OWNER Mo
 LOGGED BY H. F. Edwards DATE 11-16-67 PROJECT: WP-07 WP-08 5
 DRILLING EQUIPMENT Fauling 1500 LOCATION OF HOLES 2 Fill FP-03 5 P.L. 46

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U S C S	N	TYPE BIT USED	SAMPLES			
							1 NO. TYPE	2 FROM FT.	3 TO FT.	4 CSE. REM. MIN. DIAM.
1	1775 913.4	1.5 8	Silt, slightly clayey, dark grayish brown, top soil	ML SA						
		1.5	Clay, silty, yellowish brown and gray, moist, stiff till	CL SA						
		8	20 Clay, silty, reddish brown and yellowish brown, moist, stiff till	CL SA						

W.L. 16' 11-27-67

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co. STATE Mo
 LOGGED BY N.F. Edmunds DATE 11-15-67 PROJECT: WP-07 WP NO. 5 P.L. 46
 DRILLING EQUIPMENT Fauling 1500 LOCATION OF HOLES & Fill

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U TYPE			SAMPLES		
					S	BIT USED	NO.	1 FROM TO FT. FT.	2 CSE. REM. MIN. INCH	3 REC. INCH
2	7170 993.0	0 2 2 10	Silt. clayey, dark grayish brown topsoil clay, silty, yellowish brown and gray slightly moist, stiff, subsoil		ML SA					
		10 176	clay, silty, reddish brown, moist, stiff fill		CL SA					
		176 18	Limestone		CL SA					
		18 272	Limestone, gray, thinly bedded with interbedded gray shale, shale beds mostly 1/4 to 1/2 inch thick, one shale bed from 21 to 21.4. Pressure test was made from 18.5' to 27.2'. No water loss.		SA					
					Red					

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BCS-5317
7-64

LOG OF TEST HOLES

WATERSHED	LOCATION	SUB-WATERSHED	SITE NO.
Panther Creek	Harrison County		C-2
LOGGED BY	DATE	OWNER	STATE
M. F. Edwards	11-14-67		Mo
DRILLING EQUIPMENT		PROJECT	
Failing 1500		WP-07	
		WP-08	
		FP-03	
		PL-46	
		LOCATION OF HOLES	
		2 Fill	

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM, TO FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE BIT USED	SAMPLES			
							1 NO. TYPE	2 FROM TO FT. FT.	3 CSE. REM. IN IN	4 REC. IN IN
3	5100 888.6	0 7.8 7.8 8.3 8.3 9.5 9.5 9.9 9.9 11.9 11.9 16.8 16.8 17.8 17.8 20	Clay, very silty with some fine sand, dark grayish brown, moist, medium alluvium sand, silty, grayish brown, wet, medium fine & medium sand with 20% fines Clay, silty with sand and gravel, dark grayish brown, saturated medium Limestone, weathered, with clay. Limestone, weathered Limestone, with interbedded gray shale, limestone thinly bedded, shale, gray, Shale, black, hardness 4, laminated.		CL SA SM SA CL SA SA Acid					30 100 90 90

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LOG OF TEST HOLES

WATERSHED

LOCATION

LOGGED BY

DRILLING EQUIPMENT

DATE

PROJECT

LOCATION OF HOLES

STATE

SUR-WATERSHED

OWNER

WP-07

WP-08

FP-03

P.L. 48

SITE NO.

C-2

Mo

9CS-5337

1-1-64

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1-1-64

1-1-64

Panther Creek
Harrison Co
N E Edmonds
11-9-67
Failing 1500

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U S C S	N	TYPE BIT USED	SAMPLES			
							1 NO.	2 TYPE	3 FROM TO FT. FT.	4 CSE. REAM % DIAM
4	6725 885.5	0 2	silt, clayey, with some sand, dark grayish brown, moist, medium sand, silty, yellowish brown and grayish brown, estimated 15% fines with occasional gravel	ML		SA				
		2 6.5	Limestone, refusal	SA		SA				
		6.5	Caved at 2.5' 11-27-67							

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SOIL CONSERVATION SERVICE

SCS-5337
REV. 7-64

LOG OF TEST HOLES

WATERSHED Panther Creek SUB-WATERSHED 1 SITE NO. C-2
 LOCATION Harrison Co OWNER Mo STATE Mo
 LOGGED BY N F Edmonds DATE 11-9-67 PROJECT: WP-07 WP-08 5 FP-03 P.L. 46
 DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES 2 Fill

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE BIT USED	SAMPLES			
							1 FROM TYPE FT.	2 TO CSE. REM. FT.	3 REC. MIN. INCHES	4
5	6+80	0	1 Clay, silty, reddish brown, moist		CL	SA				
	6870	1	medium, slope wash							
		4	Silt, clayey, dark grayish brown, moist, medium alluvium		ML	SA				
		4	Limestone, weathered, w/clay.			SA				
		5	Limestone, refusal							
5a	6+55	0	3.5 Silt, clayey, dark grayish brown, moist		CL	SA				
	8870		medium, alluvium							
		35	Gravel, clayey, yellowish brown		GC	SA				
		6.5	Refusal at 6.5'							
			w.L. 5' 11-27-67							

SHEET 1 OF 1 SHEETS

3. PERCENT SAMPLE RECOVERY

2. COARSE MATERIAL REMOVED

1. DISTURBED UNDISTURBED ROCK CORE

LOG OF TEST HOLES

WATERSHED	Panther Creek	SUB-WATERSHED	
LOCATION	Harrison Co	OWNER	
LOGGED BY	N F Edmonds	PROJECT:	
DRILLING EQUIPMENT	Failing 1500	DATE	11-8-67
		WP. 0. 5	WP. 08 5
		EP. 03	P.L. 46
		LOCATION OF HOLES	Fill

SITE NO. C-2
STATE MO

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM, TO FT. FT.	DESCRIPTION OF MATERIALS	M	U S C S	U TYPE S	NO.	I TYPE	SAMPLES									
									FROM FT.	TO FT.	CSE. REM. MIN. INCHES							
# 6	7725	0	clay, silty, reddish brown, slightly moist, stiff clay, sandy, reddish brown, moist, stiff estimated 30% fine sand sand, clayey, reddish brown, moist, medium, fine sand with estimated 35% fines clay, silty, reddish brown, moist, stiff Limestone, weathered Limestone, refusal Overburden		CL SA													
	896.3	6										CL SA						
		8										SC SA						
		9										CL SA						
		9.5										SA						
		9.8										SA						
	7130	0	Limestone, thinly bedded, light brown and weathered but has hardness of 4 to 5 Limestone, gray, thinly to medium beds, hardness of 3, with interbedded gray shale shale beds range in thickness from 1/4" to 3"		SA													
	9.2	SA																
	13.0	Red																

1. DISTURBED UNDISTURBED ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET 1 OF 1 SHEETS

LOG OF TEST HOLES

WATERSHED Panther Creek LOCATION Harrison Co DATE 11-8-67

LOGGED BY N.F. Edmunds DRILLING EQUIPMENT Falling 1500

SUB-WATERSHED WP-07 OWNER Mc PROJECT: 2 Fill

SITE NO. C-2 STATE Mo WP-08 5 FP-03 P.L. 46

LOCATION OF HOLES

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM SURFACE FT.	DESCRIPTION OF MATERIALS	N	U S C S	U T Y P E B I T U S E D	SAMPLES			
							1 NO. TYPE	2 FROM TO FT.	3 CSE REM. REC.	4 MIN DIAM. IN.
7	8+00 896.5	0 1	silt, slightly clayey, dark brown Top soil		ML SA					
		1 2	silt, slightly clayey, grayish brown, moist, medium		ML SA					
		2 9	clay, silty, yellowish brown and gray slightly moist, hard, becomes moist and stiff at 6 feet		CL SA					
		9 10	clay, gravelly, dark brown, moist stiff, coarse sand and fine gravel estimated 35%		CL SA					
		10 13	Gravel, clayey, reddish brown, moist to very moist Refusal with auger at 13.2		GC SA		1 D	10 11		
		13.2 24.4	Limestone with interbedded shale beds at 14.5 to 18.8; 16.6 to 16.9; 19.8 to 20.3							
		24.4 26.5	shale		RB					

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2

LOCATION Harrison Co. STATE MO

LOGGED BY N. F. Edmonds DATE 11-8-67

DRILLING EQUIPMENT Failing 1500 PROJECT: WP-07 WP-08 5 FP-03 P.L. 48

OWNER WP-07 LOCATION OF HOLES Q Fill

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U TYPE	SAMPLES		
						NO. TYPE	FROM TO FT. FT.	CSE. REM. REC. MIN. % DIAM. %
8	9100 8974	0 2	Silt, slightly clayey, brown and grayish brown moist topsoil		ML SA			
		2 9	Clay, silty, reddish brown, moist stiff		CL SA			
		9 10.4	Sand, clayey, reddish brown, moist medium, medium to coarse angular sand with occasional gravel, estimated 30 to 35% fines		SC SA			
		10.4 10.6	Limestone, weathered		SA			
		10.6	Limestone, refusal w.L. 9.5 11-27-67					

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SOIL CONSERVATION SERVICE

BCS-9337
REV. 2-64

LOG OF TEST HOLES

WATERSHED Panther Creek SUB-WATERSHED C-2
LOCATION Harrison Co OWNER MO
LOGGED BY N.F. Edmonds DATE 11-8-67 PROJECT WP-07
DRILLING EQUIPMENT Feiling 1500 LOCATION OF HOLES 9 Fill

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U TYPE			SAMPLES		
					U	S	C	1 FROM FT.	2 TO FT.	3 CSE. REM. MIN. DIAM. IN.
9	11400 901.6	0 1 1 7	silt, slightly clayey, topsoil clay, silty, yellowish brown and gray, moist, stiff		ML	SA				
		7 10	clay, silty, with some fine sand, reddish brown, moist, stiff		CL	SA				
		10 144	sand, clayey, reddish brown, moist medium, fine & medium sand with estimated 30% fines		SC	SA				
	1440.6		limestone, weathered		SA					
	146		limestone, refusal w.L. 11' 11-27-67							

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SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2 STATE MO

LOCATION Harrison Co SUB. WATERSHED _____

LOGGED BY NFE Edwards DATE 11-7-67 PROJECT: WP-07 WP-08 5 PP-03 _____ PL-48 _____

DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES 3 Fill

HOLE NO	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO	DESCRIPTION OF MATERIALS	N	U S C S	TYPE RIT USED	SAMPLES		
							1 FROM TO	2 CSE. REM. MIN. DIAM	3 REC.
		FT. FT.					FT.	FT.	%
10	12+50 904.8	0 1	silt, slightly clayey, dark grayish brown very moist, medium top soil		ML SA				
		1 6	clay, silty, grayish brown and yellowish brown, moist, medium		CL SA				
		6 9	clay, dark grayish brown and gray, moist, stiff		CH SA				
		9 13	clay, silty, reddish brown, moist, medium, fill		CL SA				
		13 18	clay, silty, yellowish brown and gray, moist, medium, slightly sandy from 16 to 18', fill. w.L. 10.5 11-27-67		CL SA				

SHEET 1 OF 1 SHEETS

3. PERCENT SAMPLE RECOVERY

1. DISTURBED UNDISTURBED ROCK CORE 2. COARSE MATERIAL REMOVED

SCS-9337
REV. 2-64

LOG OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED	LOCATION	LOGGED BY	DRILLING EQUIPMENT	DATE	PROJECT	LOCATION OF HOLES	PP. 03	PL. 46
Panther Creek	Harrison Co.	N. F. Edmonds	Failing 1500	11-16-67	WP-07	WP-08	5	14700
SUB-WATERSHED	OWNER	STATE	SITES NO. C-2					
		Mo						

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U	S	C	BIT USED	NO.	TYPE	SAMPLES		
											1 FROM FT.	2 TO CSE. FT.	3 REM. REC. MIN. DIAM. IN.
11	14700	0	1 silt, clayey, brown, Top soil					ML SA					
	911.0	1	3 clay, silty, yellowish brown and gray, moist, stiff					CL SA					
		3	10 Clay, silty, reddish brown, moist, stiff					CL SA					
		10	16 Clay, silty, yellowish brown and gray moist, stiff, Till					CL SA					
			wt. 3' 11-27-67										

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

BCS 3337
REV. 2-64

LOG OF TEST HOLES

WATERSHED	LOCATION	SUB-WATERSHED	OWNER	SITE NO.	STATE
Panther Creek	Harrison Co			C-2	MO
LOGGED BY	DATE	PROJECT	WP-07	WP-08	PL-46
N.E. Edmonds	11-14-67	LOCATION OF HOLES	Q Fill		
DRILLING EQUIPMENT	Failing 1500				

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U S C S	N	U S C S	BIT USED	SAMPLES		
								1 NO. TYPE	2 FROM TO FT. FT.	3 CSE. REM REC. MIN. DIAM %
12	3440 881.0	0.16 1.634 3.466	Sand, w limestone cobbles, channel fill Limestone, with interbedded shale, predominately shale with poor recovery from 2.4 to 3.2. Upper limestone appears thinly bedded and unweathered Limestone, thinly to medium bedded with thin interbedded shale seams, sound limestone, hardness 5				SA red ↓			50 100

Panther Creek

Harrison Co

N.F. Edmunds

Failing 1500

11-17-67

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LOG OF TEST HOLES

SOIL CONCENTRATION SERVICE		REV. 7-66	
WATERSHED	Panther Creek	SUB-WATERSHED	
LOCATION	Harrison Co	OWNER	
LOGGED BY	NF Edmonds	PROJECT:	
DATE	11-16-67	WP-07	WP-08 5
DRILLING EQUIPMENT	Failing 1500	LOCATION OF HOLES	£ 1400 Grid C400
		PP-03	PL-46
		SITE NO.	C-2
		STATE	MO

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U		TYPE BIT USED	SAMPLES			
					S	C		1 NO. TYPE	FROM TO FT. FT.	2 CSE. REM.	3 REF.
103	904.5	0 1	Clay, silty, dark grayish brown Top soil		CL	SA					
		1 4	Clay, silty, reddish brown, moist stiff-till		CL	SA					

1. DISTURBED-UNDISTURBED-ROCK CORE

2. COARSE MATERIAL REMOVED

3. PERCENT SAMPLE RECOVERY

SHEET _____ OF _____ SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED
LOCATION
LOGGED BY
DRILLING EQUIPMENT

Panther Creek
Harrison Co
N. F. Edwards
Falling 1500

DATE
11-27-67

PROJECT
WP 07
LOCATION OF HOLES
6-100 Grid C100

SUB-WATERSHED
OWNER
STATE
MO

FP 03
PL 46

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE BIT USED	SAMPLES			
							1 TYPE NO.	2 FROM FT.	3 TO FT.	4 CSE. REM MIN DIAM
102	893.6	0.5	silt, slightly clayey, dark brown alluvium becomes very moist at 5			MLSA	1	0	0.4	
		5.6	silt, slightly sandy, very moist			MLSA				

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET 1 OF 1 SHEETS

SCS-9317
REV. 2-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED <i>Panther Creek</i>	SUB-WATERSHED	SITE NO. <i>C-2</i>
LOCATION <i>Harrison Co</i>	OWNER	STATE <i>Mo</i>
LOGGED BY <i>N. F. Edmonds</i>	DATE <i>11-27-67</i>	PROJECT <i>WP-07</i>
DRILLING EQUIPMENT <i>Failing 1500</i>	LOCATION OF HOLES <i>Q 12+00 Grid B+00</i>	PL-46 <i>WP-03</i>

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U N C S	TYPE BIT USED	SAMPLES		
						1 FROM TYPE FT.	2 TO CSE. REM. MIN DIAM. %	3 RFC.
111	895.9	0 2	silt, clayey, with some sand, dark grayish brown alluvium	ML	SA			
		2 8	silt, clayey, dark grayish brown and brown, alluvium. W.L. 7.5' E.O.D	ML	SA	1 0 0 6		
104	896.3		Q 14+00 Grid C+50					
		0 5	clay, silty, with some sand dark grayish brown alluvium	DL	SA	1 0 0 5		
		5 8	clay, silty, dark grayish brown, alluvium, becomes too and for borrow at 6'					

LOG OF TEST HOLES

WATERSHED Panther Creek
LOCATION Harrison Co.
LOGGED BY N F Edmonds
DATE 11-16-67
DRILLING EQUIPMENT Failing 1500

SUR-WATERSHED 1
OWNER 1
PROJECT: WP-07
LOCATION OF HOLES Fill 1400 Grid D+50

SITE NO. C-2
STATE Mo
PROJECT: WP-08
P.L. 46

LOGS BY 1
DATE 11-16-67
PROJECT: WP-08
P.L. 46

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE BIT USED	NO.	I TYPE	FROM TO FT. FT.	CSE. REF. 1/2 INCH	REC. 3
105	897.0	0 2	silt clayey, dark grayish brown and grayish brown top soil			ML SA	1	D	0 2		
		2 8	Clay, silty, reddish brown, moist medium			CL SA	2	D	2 8		
		8 10	Sand, clayey, brown, very moist, estimated 30% fines			SC					
109	894.9		Fill 3400 Grid D+50								
		0 6	silt, clayey, w/some sand, dark grayish brown, moist alluvium			ML SA	1	D	0 6		
		6 8	Sand, clayey, reddish brown, very moist, estimated 30% fines			SC SA					

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-9537
REV. 2-66

LOG OF TEST HOLES

WATERSHED <i>Parther Creek</i>	SUB-WATERSHED	SITE NO. <i>C-2</i>
LOCATION <i>Harrison Co</i>	OWNER	STATE <i>MD</i>
LOGGED BY <i>N F Edmonds</i>	DATE <i>11-27-67</i>	PROJECT <i>WP 07 WP 08 5 TP 03 P.L. 46</i>
DRILLING EQUIPMENT <i>Failing 1500</i>	LOCATION OF HOLES <i>Q 12+00 Grid E+00</i>	

HOLE NO	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES					
				U S N	TYPE BIT C S	NO. USED	1 FROM FT.	2 TO FT.	3 REL REC. N
101	900.7	0 3.5	silt, clayey, dark brown slopewash clay, silty, yellowish brown and grey moist, stiff silty clay, grayish brown, moist to very moist, soft. W.L. 11' F.O.D.	ML CL CL	SA SA SA	1 2 3	0 0 0	3.5 8 8	
		3.5 8							
		8 12							
106	895.8	0 2	Q F, 11 10+00 Grid D+00 silt, slightly clayey, dark yellowish brown, alluvium silt, slightly clayey, dark grayish brown alluvium silt, sandy, reddish brown, moist to very moist at 6'	ML ML ML	SA SA SA	1 1 1	0 0 0	4 4 4	
		2 4							
		4 8							

1. DISTURBED-UNDISTURBED ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET 1 OF 1 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-3317
REV. 2-64

LOG OF TEST HOLES

WATERSHED <i>Panther Creek</i>	SUB-WATERSHED	SITE NO. <i>C-2</i>
LOCATION <i>Harrison Co</i>	OWNER <i>✓</i>	STATE <i>MO</i>
LOGGED BY <i>N. F. Edmonds</i>	DATE <i>11-16-67</i>	PROJECT <i>WP-07</i>
DRILLING EQUIPMENT <i>Failing 1500</i>	LOCATION OF HOLES <i>Fill 3+00 Grid C450</i>	PL. 46 <i>5</i>

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES				
				U S C S	N	TYPE BIT USED	1 FROM FT.	2 TO FT.
108	898.3	0 1	Silt, slightly clayey, dark grayish brown top soil.	ML	SA			
		1 2	Silt, slightly clayey, grayish brown moist, medium alluvium	ML	SA			
		2 10	Clay, silty, reddish brown, moist medium.	CL	SA	1 D 2 10		
		10 12	Sand, clayey, brown, very moist, medium, estimated 35% fines No wt. 11-27-67	SC	SA			

1. DISTURBED-UNDISTURBED ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY SHEET OF SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS 9117
REV. 7-64

LOG OF TEST HOLES

WATERSHED <i>Panther Creek</i>		SUB-WATERSHED <i>C-2</i>	
LOCATION <i>Harrison Co</i>		STATE <i>Mo</i>	
LOGGED BY <i>NE Edmonds</i>	DATE <i>11-16-67</i>	PROJECT WP-07 WP-08 <i>5</i> FP-03 P.L. 46	
DRILLING EQUIPMENT <i>Failing 1500</i>		LOCATION OF HOLES <i>Fill 1450 C+00</i>	

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U S C S	N	TYPE	SAMPLES			
							1 FROM FT.	2 TO FT.	3 CSE REC. MIN. IN. MAX. IN.	4
110	901.0	0 1.5	silt, clayey, dark grayish brown Top soil	MLSA						
		1.5 8	Clay, silty, reddish brown, moist medium, Terrace alluvium	CLSA						
		8 10	sand, clayey, brown, very moist medium to w.L. 11-27-67	SCSA						

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co STATE Mo
 LOGGED BY N. F. Edmonds DATE 11-20-67
 DRILLING EQUIPMENT Feeling 1500 PROJECT: WP-07 WP NO. 5 P.L. 46
 SUB-WATERSHED OWNER LOCATION OF HOLES Energy Spilly

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES				
				U S C S	TYPE BIT USED	NO.	FROM TO FT. FT.	1 TYPE FT. FT.
201	3100 930.5	0 4.8	clay, silty, yellowish brown and gray, Till, Refusal at 4.8		CL 50			
		4.8 6.2	Limestone, weathered, broken		Red			
		6.2 8.2	Limestone, gray, hard, thickly bedded					
		8.2 9.6	shale, yellowish brown, one lime-stone bed from 8.8 to 8.9.					
		9.6 11.4	Limestone, thin to medium beds with interbedded yellowish brown shale					
		11.4 20	Limestone, gray and dark gray, hard medium bedded. Thin shale bed from 13.9 to 14.0					

803-5337
REV. 2-61

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED <i>Panther Creek</i>		SUB-WATERSHED		SITE NO. <i>C-2</i>	
LOCATION <i>Harrison Co</i>		OWNER		STATE <i>MD</i>	
LOGGED BY <i>N.E. Edmonds</i>	DATE <i>11-22-67</i>	PROJECT <i>WP-07</i>	WP-08 <i>5</i>	PP-03	PL-46
DRILLING EQUIPMENT <i>Failing 1500</i>		LOCATION OF HOLES <i>Emerg. Spilly</i>			

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES					
				U	N	S	C	1 FROM TYPE	2 TO CSE. REM. MIN. INDIAM. REC. %
202	4100 937.7	0 6	Clay, silty, yellowish brown and gray moist stiff fill Refusal at 6'	CL SA					
		6 8.5	Limestone, gray & buff, weathered, 2 beds 2' and 5' thick, one thin yellowish brown shale bed at 8'						90
		8.5 11.5	shale, yellowish brown, with thin interbedded limestone less than 1" thick						70
		11.5 16	Limestone, gray, thin and medium bedded with interbedded dark gray shale and shaly limestone						100

SHEET 1 OF 1 SHEETS

3. PERCENT SAMPLE RECOVERY

2. COARSE MATERIAL REMOVED

1. DISTURBED-UNDISTURBED-ROCK CORE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-9397
REV. 2-64

LOG OF TEST HOLES

WATERSHED Panther Creek SUB-WATERSHED C-2
LOCATION Harrison Co STATE Mo
LOGGED BY N. F. Edmonds DATE 11-22-67 PROJECT: WP OF 5
DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES Q. Emerg Sply 100' right

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U	S	C	S	TYPE	SAMPLES			
										1 FROM FT.	2 TO FT.	3 CSE REAM REC.	4
203	4400 944.5	0 .5 5 10.3	Silt, clayey, brown topsoil clay, silty yellowish brown and gray moist, stiff, till						ML SA				
		10.3 11.8	Limestone, light gray & buff, thinly bedded with interbedded yellowish brown shale, weathered						CL SA	1	0.5	10	
		11.8 16.3	Limestone, light gray, medium bedded with thin shale partings						Red				100
		16.3 18.2	Shale, yellowish brown with interbedded limestone beds about 1" thick										100
		18.2 20.4	Limestone, gray, with interbedded dark gray shale and shaly limestone										100

SCS-9337
REV. 2-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED <i>Ranther Creek</i>	SUB-WATERSHED	SITE NO. <i>C-2</i>
LOCATION <i>Harrissey Co</i>	OWNER	STATE <i>Mo</i>
LOGGED BY <i>N. F. Edmunds</i>	DATE <i>11-21-67</i>	PROJECT <i>WP-07</i>
DRILLING EQUIPMENT <i>Failing 1500</i>	LOCATION OF HOLES <i>Emerg Spiny</i>	WP-08 <i>5</i>
		P.L.-46

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM, TO FT. FT.	DESCRIPTION OF MATERIALS	N	SAMPLES						
					U	TYPE	NO.	1 TYPE	2 FROM, TO FT. FT.	3 CSE. REM. %	
					S	BIT USED					
04	5100 932.0	0	2.5 Clay, silty, yellowish brown and gray Till Refusal at 2.5'		DL	SA					
		2.5	5.7 Limestone, weathered, broken w/ clay			Rb					
		5.7	7.3 Shale, yellowish brown, with interbedded thin limestone beds.			Red					
		7.3	15.7 Limestone, gray, thin and medium bedded with interbedded gray shale and shaly limestone.								

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY SHEET *1* OF *1* SHEETS

LOG OF TEST HOLES

WATERSHED Panther Creek
LOCATION Harrison Co
LOGGED BY N. F. Edwards
DATE 11-21-67
DRILLING EQUIPMENT FALLING 1500

SUB-WATERSHED
OWNER
PROJECT
LOCATION OF HOLES

SITE NO. C-2
STATE Mo
WP-07
WP-08 5
FP-03
P.L.-46

DESCRIPTION OF MATERIALS

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U N C S	TYPE BIT USED	SAMPLES			
						1 NO. TYPE	2 FROM TO CSE. REM. REC.	3 FT. FT. N	4 FT. N
207	2100 9185	018.5	Clay, silty, yellowish brown and gray moist, stiff, Till		CLSA				
		8.5 96	Limestone, weathered with clay		SA				
		96 136	Limestone, gray, thinly bedded with interbedded yellowish brown shale		Red				

50

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED	Panther Creek		SUB-WATERSHED		SITE NO.	C-2
LOCATION	Harrison Co		OWNER		STATE	Mo
LOGGED BY	W. F. Edmunds		PROJECT		PL-46	
DATE	11-22-67		LOCATION OF HOLES	Emerg Salway		
DRILLING EQUIPMENT	Failing 1500		WP-07	WP-08	5	FP-03

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	U S C S	N	U S C S	TYPE BIT USED	SAMPLES		
								1 FROM TO CSE. REM. REC.	2	3
								TYPE FT. FT. %	MIN. DIAM	
208	2150 924.5	0 3.3	clay, silty, yellowish brown and gray, m. st, stiff Refusal at 3.3				CL SA			
209	2125 921.5	0 4.3	clay, silty, yellowish brown and gray, moist, stiff Refusal at 4.3.				CL SA			

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DCS 5337
REV. 2-61

LOG OF TEST HOLES

WATERSHED Panther Creek SUB-WATERSHED _____ SITE NO. C-2
LOCATION Harrison Co OWNER ✓ STATE MD
LOGGED BY N. F. Edmonds DATE 11-22-67 PROJECT: WP-07 WP-08 5 PP-03 P.L. 46
DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES G. Emery Sply

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U	TYPE	NO. USED	1 FROM FT.	2 TO FT.	3 CSE REM. REC. MIN. INCH. N
210	920.5	0	clay, silty, yellowish brown and gray, moist, stiff Limestone weathered, broken, with clay weathered piece, yellowish brown. Refusal at 3.5		CL	SA				
	512.5									
	929.5	1								
211	5150	0	Clay, silty, yellowish brown and gray moist stiff Refusal at 2.6		CL	SA				
	926.5									

BCS-9317
REV. 2-66

LOG OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED

LOCATION

LOGGED BY

DRILLING EQUIPMENT

DATE

PROJECT:

LOCATION OF HOLES

WATERSHED

SITE NO.

STATE

OWNER

Pea River Creek

Harrison Co

M. F. Edmonds

11-27-67

Emergency Spillway

WP-07

WP-06

5

PL-46

Mo

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT.	DESCRIPTION OF MATERIALS	U S C	N	S	TYPE	SAMPLES		
								1 FROM TO NO. TYPE FT. N	2 CRE. REM MIN. DIAM	3 REC. %

215	921.5 6100	0 3.2	clay, silty, yellowish brown, moist, stiff Refusal at 3.2	CL			SA			
212	4100 100' Lt. 924.7	0 4.8	clay, silty, yellowish brown, moist, stiff Refusal at 4.8	CL			SA			
213	4100 50' Lt. 931.0	0 4	clay, silty, yellowish brown, moist, stiff Refusal at 4.0	CL			SA			

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY SHEET 1 OF 1 SHEETS

LOG OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co STATE Mo
 LOGGED BY N.F. Edwards DATE 11-22-67
 DRILLING EQUIPMENT Emerysplay 150' right

PP-03 PL-46

WP-08 5

WP-07

PROJECT

LOCATION OF HOLES

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES					3
				U	S	C	N	1 FROM TO CSE. REM MIN DIAM	
214	4100 946.8	0 .5	silt, slightly clayey, dark brown topsoil	ML SA					
		.5	clay, silty, yellowish brown and gray, moist, stiff, fill	CL SA					

SCS 3337
REV. 2-64

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED Parthen Creek SITE NO. C-2
 LOCATION Harrison Co STATE MO
 LOGGED BY A.E. Edwards DATE 12-6-67
 DRILLING EQUIPMENT Failing 1500 PROJECT: WP-07 WP-08 5 P.L. 46
 SUB-WATERSHED OWNER LOCATION OF HOLES Emergency Spillway

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT.	DESCRIPTION OF MATERIALS	U N C S	BIT USED	SAMPLES		
						1 FROM TYPE FT.	2 TO CSE. REM. MIN. IN FT.	3 REC. IN
221	3100 922.3	0 5	100 feet Left clay, overburden Refusal at 5'	CL SA				
220	3100 926.4	0 14	50 feet Left clay, overburden Refusal at 14'	CL SA				
219	3100 932.0	0 27 2.7 13.4	50 feet Right clay, overburden clay and broken rock Refusal at 3.4'	CL SA CL SA				
218	3100 932.4	0 18 4.8 5	100 feet Right clay, overburden clay & broken rock Refusal at 5'	CL SA				

UNCLASSIFIED

BLACK AND VEATCH KANSAS CITY MO F/6 13/13
NATIONAL DAM SAFETY PROGRAM, HARRISON COUNTY DAM C-2 (MO 10614)--ETC(U)
MAR 81 E R BURTON, H L CALLAHAN DACW43-81-C-0037

F/G 13/13

PACW43-81-C-0037

NL

2 of 2

ΔΟΡΟΦΟΡΟΣ

END

DATE _____

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L. L. C.

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DTIC

BCS 9337
REV. 2-61

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED <i>Panther Creek</i>		SUB-WATERSHED	SITE NO. <i>C-2</i>
LOCATION <i>Harrison Co</i>		OWNER	STATE <i>Mo</i>
LOGGED BY <i>N.F. Edmonds</i>	DATE <i>12-5-67</i>	PROJECT <i>WP-07</i>	FL-46 <i>WP-08-5</i>
DRILLING EQUIPMENT <i>Failing 1500</i>		LOCATION OF HOLES <i>Emergency Spillway</i>	

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE RIT USED	SAMPLES				
							NO.	1 TYPE	FROM, TO FT. FT.	2 CSE. REM. MIN DIAM	3 REC.
217	919.8 918.8 2100	0 4.3 4.3 5.2	64 feet Right Clay, overburden Clay & broken rock Refusal at 5.2		CL SA CL SA						
216	923.0 2100	0 3.4	96 feet Right Clay, overburden Refusal at 3.4		CL SA						

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY SHEET ____ OF ____ SHEETS

LOG OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOCATION: Panther Creek
WATERSHED: Harrison Co
LOGGED BY: N. F. Edwards
DATE: 12-6-67
DRILLING EQUIPMENT: Failing 1500

SITE NO. C-2
STATE: MO
SUR. WATERSHED: WP-07
OWNER: WP-08
PROJECT: 5
P.L. 46

LOCATION OF HOLES: Emergency Spillway

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM, TO FT.	DESCRIPTION OF MATERIALS	U N C S	TYPE BIT USED	1 FROM FT.	2 TO FT.	3 CSE. REM. MIN. DIAM. %
226	5100 924.4	0 2.4 2.4 4.3 4.3 5.7	100 feet left clay, overburden clay and broken rock wea. limestone Refusal at 5.7		CL SA			
225	5100 929.4	0 4.6 4.6 5	50 feet left clay, overburden wea. limestone		CL SA			
224	5100 921.0	0 0.7	50 feet Right overburden Refusal at .7		CL SA			
223	5100 920.5	0 5 5 6.6	100 feet Right clay, overburden clay & broken rock Refusal at 6.6		CL SA			

1. DISTURBED-UNDISTURBED-ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY

SHEET ____ OF ____ SHEETS

LOG OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED Panther Creek LOCATION Harrison Co SUB-WATERSHED Mo OWNER Mo

LOGGED BY N.F. Edmonds DATE 11-9-67 PROJECT WP-07 SITE NO. C-2 STATE Mo

DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES 8 Prin. Spillway WP-08 5 P.L. 46

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	SAMPLES				
					U TYPE	NO.	1 TYPE	2 FROM TO CSE. REM	3
					BIT USED		FT.	FT.	MIN. DIAM. IN.
301	1750 0 12 8890	2	silty, clayey, with some fine sand, dark grayish brown, moist, medium, alluvium		ML SA	1	U 3	5.2	
		4	clay, very silty, dark grayish brown moist, medium		CL SA				
		4	clay, very silty, with some fine & medium sand, moist, medium, brown		CL SA				
		6	sand, silty, yellowish brown and grayish brown, saturated, soft, fine & medium sand with estimated 15% fines, occasional limestone gravel in lower part		SM SA	2	U 6.5	5.2	
		98	Limestone, refusal						

Hole caved 6.5' 11-27-67

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co STATE Mo
 LOGGED BY N.E. Edmonds DATE 11-9-67
 DRILLING EQUIPMENT Failing 1500 PROJECT WP-07 WP-08 5 P.L. 46
 OWNER Q. Fill LOCATION OF HOLES Q. Fill

HOLE NO.	STA & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	N	U S C S	TYPE USED	SAMPLES			
							1 FROM FT.	2 TO FT.	3 CSE. REF. MIN. DIAM.	4 RFC. N
302	4100 8893	0 3	silty silt, sandy, dark grayish brown moist, medium, alluvium			ML SA				
		3 6	sand, silty, reddish brown, moist medium, fine & medium sand with estimated 15% fines			SA SA				
		6 8	Clay, very silty, with some sand, dark grayish brown, moist, medium alluvium			CL SA				
		8 10	Sand, silty, dark grayish brown, saturated, soft			SA SA				
		9 10.2	Clay silty, yellowish brown, moist medium			CL SA				
		10.2/10.4	Limestone, refusal W.L. 7.5' 11-27-67			SA				

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WCS-9337
REV. 2-64

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co STATE Mo
 LOGGED BY N. F. Edmonds DATE 11-9-67
 DRILLING EQUIPMENT Failing 1500 PROJECT: WP-07 WP-08 S PP-03 S P.L.-46

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES				
				U	S	C	NO. TYPE	1 FROM TO CSE. REM. REC. MIN. DIAM.
303	2450 889.6	0 3	silt, slightly clayey with fine sand dark grayish brown moist alluvium	N				
		3 6	clay, silty, with fine sand, brown moist, medium				MA SA	
		6 9	clay, silty, dark grayish brown, moist medium alluvium				CL SA	
		9 10	sand, clayey, yellowish brown, saturated soft, fine & medium sand with occasional gravel, estimated 25% fines				CL SA	
		10 11.3	clay, gravelly, yellowish brown, moist, stiff				SC SA	
		11.3	limestone, refusal				CL SA	

1. DISTURBED UNDISTURBED ROCK CORE 2. COARSE MATERIAL REMOVED 3. PERCENT SAMPLE RECOVERY SHEET 1 OF 1 SHEETS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

4CS-9317
REV. 2-64

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co. STATE Mo
 LOGGED BY N. F. Edmonds DATE 11-15-67
 DRILLING EQUIPMENT Fairling 1500 PROJECT: WP-07 WP-08 5 P.L. 48
 LOCATION OF HOLES 2 Prin. Spillway

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM TO FT. FT.	DESCRIPTION OF MATERIALS	SAMPLES				
				U	TYPE	NO.	1 FROM TYPE FT.	2 TO CSE. REM. MIN. DIAM. FT. IN.
304	3+35 881.0	0 2.5	Sand with limestone cobbles in lower part Refusal at 2.5 feet	S	SA			
		2.5 3.8	Limestone, weathered, broken	R	b			
		3.8 4.4	Limestone, sound rock	R	b			
		4.4 10.7	Limestone, thinly bedded with interbedded gray shale. Shale bed less than 1/2" thick	R	d			
		10.7 11.7	Shale, gray					
		11.7 12.5	Shale, black, hardness 4					

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

LOG OF TEST HOLES

WATERSHED Panther Creek SITE NO. C-2
 LOCATION Harrison Co STATE MO
 LOGGED BY N.F. Edwards DATE 11-9-67 PROJECT: WP-07 WP-08 5 FP-03 PL-46
 DRILLING EQUIPMENT Failing 1500 LOCATION OF HOLES Fill 6+25 50' Right

HOLE NO.	STA. & SURFACE ELEVATION	HOLE DEPTH FROM, TO FT. FT.	DESCRIPTION OF MATERIALS	N	U	TYPE	NO.	TYPE	1 FROM, TO FT. FT.	2 CSE. REM. MIN. DIAM. IN.	3 REC. %
602	6+25	0	3 silt, clayey, dark grayish brown alluvium								
	885.5	3	5 silt, sandy, brown			ML SA					
		5	6.5 sand, silty, yellowish brown, occasional gravel			ML SA					
		6.5	Limestone, refusal			SM SA					
601			Hole caved 4' 11-27-67								
	6+35		Fill 35' left.								
	885.5	0	2 silt, sandy, brown alluvium			ML SA					
		2	6 Gravel, silty, brown, estimated 15% fines			GM SA					
		6	6.3 Limestone, weathered w/ clay								
		6.3	Limestone, refusal. Hole caved 3' 11-27-67								

SCS-384
7-60

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Part III - Flow Test Data

Hole No. 6 Name of Site C-2 Fort-Ren Creek

Depth Tested: From <u>9.5</u> To <u>14.5</u> ; Formation <u>Wichita</u> P <u>5</u> psi									
Graph Plot No.	Pressure Gage psi	Total Pressure (Gage+P)	Start Time	Stop Time	Elapsed Time (Mins)	Water Meter Readings			
						Start Test	End of Test	Total Gals. Water Used	GPM
1	5	15	1615	1620	5	4.32	4.32	0	
2	15	30	1622	1624		4.32	4.35	.03	
3									
4									
5									
6									
7									

Remarks:

Depth Tested: From <u>14.5</u> To <u>23</u> ; Formation <u>Wichita</u> P <u>7</u> psi									
1	6	13	1600	1610	10	4.28	4.28	0	
2	16	23	1615	1617	2	4.28	4.28	0	
3									
4									
5									
6									
7									

Remarks:

Hole # 2

Depth Tested: From <u>15.5</u> To <u>27</u> ; Formation <u>Wichita</u> P <u>10</u> psi									
1	5	15	1500	1500	0	8.03	8.03	0	
2	10	20	1500	1500	0	8.03	8.03	0	

Remarks: water loss was about 10 percent

SCS-324
7-60

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Part III - Flow Test Data

Hole No. 3 Name of Site C-2 Panther Creek

Depth Treated: From <u>15</u> To <u>20</u> ; Formation <u>Unconsolidated</u> P <u>6</u> psi									
Graph Plot No.	Pressure Gage psi	Total Pressure (Gage+P)	Start Time	Stop Time	Elapsed Time (Mins)	Water Meter Readings			
						Start Test	End of Test	Total Gals. Water Used	GPM
1	5	11	1200	1202	2	4.5	5.5	0	
2	10	16							
3									
4									
5									
6									
7									

Remarks:

Depth Tested: From <u>15</u> To <u>20</u> ; Formation <u>Unconsolidated</u> P <u>7</u> psi									
1									
2									
3									
4									
5									
6									
7									

Remarks:

Depth Tested: From ____ To ____; Formation _____ P _____ psi									

Remarks:

UNITED STATES GOVERNMENT

Memorandum

TO : James M. Dale, State Conservation Engineer,
SCS, Columbia, Missouri 65201

DATE: April 30, 1968

FROM : Lorn P. Dunnigan, Head, Soil Mechanics Laboratory,
SCS, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Missouri WP-08, Panther Creek, Site No. C-2 (Harrison County)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 3 sheets.
2. Form SCS-127, Soil Permeability, 1 sheet.
3. Form SCS-128 and SCS-128A, Consolidation Test Data, 3 sheets (1 test).
4. Form SCS-355A, Triaxial Shear Test Data, 3 sheets.
5. Form SCS-352, Compaction and Penetration Resistance, 6 sheets.
6. Form SCS-357, Summary - Slope Stability Analysis, 3 sheets.

DISCUSSION

FOUNDATION

- A. Bedrock: The bedrock consists of thin to medium bedded limestone with interbedded gray shale which has been weathered to a depth of 3 to 7 feet. The bedrock appears to be relatively uniform at elevation 887± except in the channel alluvium area where it occurs at elevation 879±. There is a hump in the bedrock at Station 6+60. The limestone bedrock is overlain, in the emergency spillway, by 2.0 to 10.0 feet of CL till.
- B. Soil Classification: Both abutments are classified CL till. The thin layer of SC material to the right of Station 9+00 is considered to be of low permeability by the geologist.
- C. Density: Undisturbed samples were taken from Test Hole 301. The sample taken from 3.0 to 5.2-foot depth has a dry density of 1.40 g/cc in the top portion and 1.76 g/cc in the lower portion. An undisturbed sample was submitted from Test Hole 301 at a depth of 6.5 to 8.7 feet. The dry density of this sample is in the range of 1.55 g/cc.

No blow counts were submitted.
- D. Consolidation: A consolidation test was made on sample No. 68W1961 "T". Based on the results of this test, and load of the embankment, the settlement in alluvium represented is estimated to approach one foot.



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2 -- James M. Dale -- 4/30/68

Lorn P. Dunnigan

Subj: ENG 22-5, Missouri WP-08, Panther Creek, Site No. C-2

- E. Permeability: A falling head permeability test was made on Sample 68W1961 "T". The results of this test show a permeability rate of 0.1 ft/day. Data on pressure tests in the bedrock are reported in the geology report.
- F. Shear Strength: A consolidated undrained shear test was made on Sample 68W1961 "T" from TH 301. The test specimens were trimmed from the undisturbed sample and soaked prior to testing. The data obtained from the test represent two strata. An average strength value of $\phi = 14.5^\circ$, $c = 400$ psf was used for design purposes.

EMBANKMENT MATERIALS

- A. Classification: The borrow samples submitted are CL and CL-ML materials. The CL materials have liquid limits ranging from 20 to 40 and PI's ranging from 9 to 20. The CL-ML materials have liquid limits of 28 and 23 and PI's of 7. The material from the emergency spillway is CH material with liquid limit of 51 and PI of 30.
- B. Compacted Density: The compacted dry density of borrow samples was 112.0 pcf for the sandier CL (68W1965), 106.0 pcf for the finer grained CL (68W1971) and 105.0 pcf (68W1972), 111.0 pcf for the Mix of samples (68W1966, 1967, 1970, 1974, 1975), and 101.0 pcf for the CH material from the emergency spillway (68W1964).
- C. Shear Strength: Consolidated undrained shear tests were made on Samples 68W1972 and Mix of 68W1966, 1967, 1970, 1974, 1975. The shear strength parameters obtained for Sample 68W1972 are $\phi = 10.5^\circ$, $c = 850$ psf. The shear strength parameters of the Mix are $\phi = 13.5^\circ$, $c = 1100$ psf. These values are for saturated material at a minimum of 95% of standard Proctor density.

SLOPE STABILITY

- A. Maximum Section at Station 6+25: A slope stability analysis was made on the 2 1/2:1 upstream embankment slope using a modified Swedish circle method. Rapid drawdown from the emergency spillway to the base of the embankment is considered. The embankment will rest on bedrock after normal channel cleanout; therefore, the foundation is considered competent. Strength parameters used for the embankment are $\phi = 10.5^\circ$, $c = 850$ psf. No berms were considered in this analysis and the computed factor of safety is 1.58.

The downstream 2 1/2:1 embankment slope stability analysis considered a full phreatic line (no drain) and a competent foundation. With embankment strength parameters of $\phi = 10.5^\circ$, $c = 850$ psf the computed factor of safety is 1.66.

3 -- James M. Dale -- 4/30/68

Lorn P. Dunnigan

Subj: ENG 22-5, Missouri WP-08, Panther Creek, Site No. C-2

- B. Floodplain Section at Station 6+10: The slope stability analysis of the 2 1/2:1 upstream embankment slope was made using the modified Swedish circle method. Rapid drawdown from the emergency spillway to the base of the embankment is considered. The embankment strength parameters used are $\phi = 10.5^\circ$, $c = 850$ psf. A foundation depth of 11 feet, strength parameters of $\phi = 14.5^\circ$ and $c = 400$ psf was considered and the computed factor of safety is 1.29. No berms were considered in the analysis.

2 - 10' berm upstream

The downstream 2 1/2:1 embankment slope stability analysis considers a full phreatic line (no drain) and an 11-foot depth of foundation. The strength parameters considered are the same as the upstream and the computed factor of safety is 1.29.

10' berm downstream

RECOMMENDATIONS

7. A. Site Preparation: Investigational data indicates that limestone outcrops in the left abutment near the left channel bank. We suggest that the bedrock-soil contact be examined for overhangs when the cutoff trench is open. If overhangs are present they should be flattened and a check made to assure there are no overhangs elsewhere.

The alluvium material has a consolidation potential in the range of 0.095 ft/ft. Because of the high consolidation potential of the alluvium we suggest that the right channel bank be flattened to a 3:1 slope to reduce differential settlement. It already is!

- B. Cutoff Trench: We concur with the engineer's recommended cutoff depths with the suggestion that concurrent with the inspection of the limestone bedrock, after the cutoff trench is open, the permeability of the SC stratum encountered in TH 8 should be evaluated to determine if it is necessary to deepen the trench in the vicinity of test hole No. 9 to cut off seepage through the foundation.
- C. Principal Spillway: Material from TH 301 is stratified alluvium. The sample submitted from TH 301 to the Laboratory was logged in the field as CL. The sample is reported to be representative of the alluvial foundation material. A consolidation test was made on this material (lab. sample 68W1961 "T") and the test indicated a relatively high consolidation potential. Based on the test data the elongation potential is estimated to be in the range of 0.011 ft/ft. If this amount of settlement is intolerable, we suggest that you consider an alternate location. It is noted that the limestone bedrock occurs at elevation 883 in the vicinity of Station 6+25 and it might be possible to bottom the conduit on bedrock.

4 -- James M. Dale -- 4/30/68

Lorn P. Dunnigan

Subj: ENG 22-5, Missouri WP-08, Panther Creek, Site No. C-2

D. Drain: Near positive cutoff is anticipated with cutoff trench depths suggested and a drain is not considered necessary for stability of the embankment.

E. Embankment Design:

1. Placement of Materials: Selective placement of materials is suggested to utilize the higher plasticity CL materials like sample No. 68W1964, 68W1971, and 68W1972 in the center portion of the embankment. This type of material is expected to be more flexible than the low plasticity materials sampled.

All materials should be placed at a minimum of 95 percent of standard Proctor density with a placement moisture controlled on the wet side of Proctor optimum.

2. Slopes: With the embankment at 95 percent of Proctor and no drain, the proposed 2 1/2:1 slopes are expected to be stable.
3. Settlement: An overfill allowance of 1.5 feet is suggested to compensate for residual consolidation within the foundation and embankment.

Prepared by:

Gerald N. Gibson
Gerald N. Gibson

Reviewed and Approved by:

Lorn P. Dunnigan
Lorn P. Dunnigan

Attachments

cc: James M. Dale (2)
E. D. Butler, Lincoln, Nebraska

[illegible]

[illegible]

MATERIALS TESTING REPORT		U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		CONSOLIDATION TEST	
PROJECT AND STATE				SAMPLE LOCATION	
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN			
TYPE OF SAMPLE	TESTED AT	APPROVED BY		DATE	
CLASSIFICATION		TEST SPECIFICATIONS			
G _s 2.65 LL 29 PI 12		Saturated at Start			
INITIAL DENSITY γ_d					
INITIAL VOID RATIO, e_0					
COMPRESSION INDEX, C_c					

VOID RATIO (e)

COEFFICIENT OF CONSOLIDATION (c_v)

PERCENT CONSOLIDATION

CONSOLIDATING PRESSURE ksf

REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		LOG TIME CONSOLIDATION	
PROJECT AND STATE				SAMPLE LOCATION	
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN			
TYPE OF SAMPLE	TESTED AT	APPROVED BY		DATE	
		L.M.S.		4-26-65	

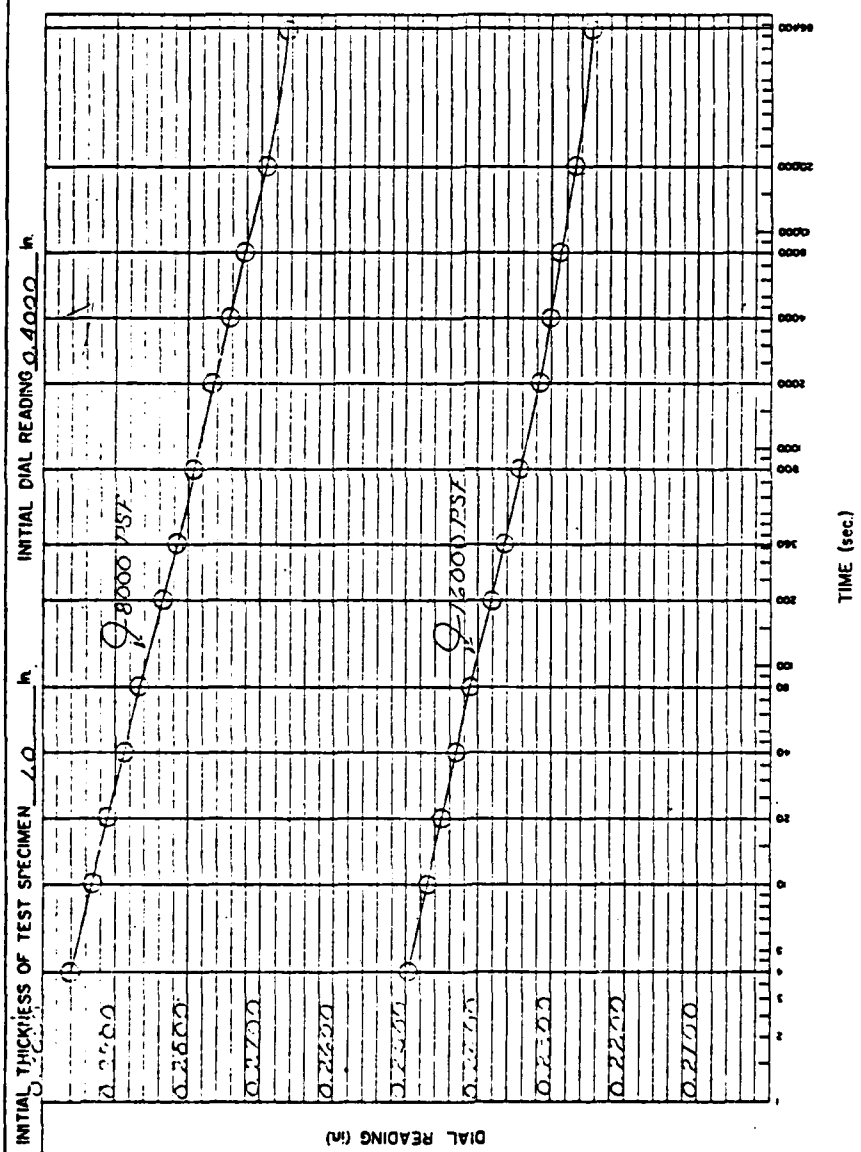
INITIAL THICKNESS OF TEST SPECIMEN 1.0

INITIAL DIAL READING 24000 in

Pressure (PSI)	Time (sec)	Dial Reading (in)
2,000	10	24000
	20	24000
	40	24000
	80	24000
	160	24000
2,200	10	24000
	20	24000
	40	24000
	80	24000
	160	24000
2,400	10	24000
	20	24000
	40	24000
	80	24000
	160	24000

REMARKS

MATERIALS TESTING REPORT		U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		LOG TIME CONSOLIDATION	
PROJECT AND STATE				SAMPLE LOCATION	
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN <i>Alloxium</i>			
TYPE OF SAMPLE	TESTED AT	APPROVED BY <i>[Signature]</i>		DATE <i>4-26-68</i>	



REMARKS

MATERIALS TESTING REPORT		U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		SOIL PERMEABILITY	
PROJECT AND STATE HARRIS COUNTY, TEXAS				SAMPLE LOCATION HARRIS COUNTY, TEXAS	
FIELD SAMPLE NO. 3A	DEPTH 3.0' - 4.0'	GEOLOGIC ORIGIN			
TYPE OF SAMPLE UNDISTURBED	TESTED AT HARRIS COUNTY, TEXAS	APPROVED BY		DATE	
CLASSIFICATION CL LL 29 PI 12				SPECIFIC GRAVITY	
TEST NO.	2060	4020	8030	4	$G_s (-)^{\circ}4$ 2.65
INITIAL MOISTURE %					$G_s (+)^{\circ}4$
DRY DENSITY $\frac{D_{100}}{D_{100}}$	1.52	1.60	1.65		$G_m (Bulk) (+)^{\circ}4$
VOID RATIO	0.7362	0.6595	0.5731		TEST SPECIFICATIONS <i>Falling Head Perm Test on the Consolidation Sample</i>
PERMEABILITY COEF FPD	0.043	0.0027	0.0036		
PERCOLATION COEF					
H_L DURING TEST					

VOID RATIO (e)

PERMEABILITY COEF (k) $FPD \times 10^{-1}$

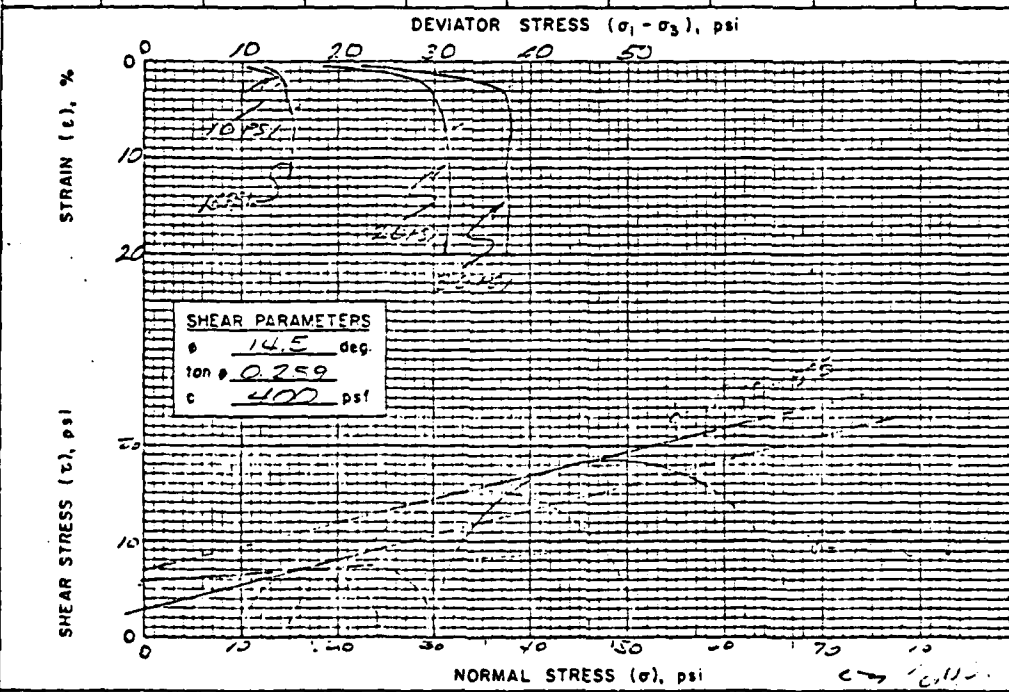
REMARKS

MATERIALS TESTING REPORT U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE TRIAXIAL SHEAR TEST

PROJECT and STATE Highway 2400 Site No. 2-2 Missouri SAMPLE LOCATION E. Pr. Sp. 1 + 50
 FIELD SAMPLE NO. 2-1-1 DEPTH 3-5.2' GEOLOGIC ORIGIN Alluvium
 TYPE OF SAMPLE undisturbed TESTED AT SMC, Lincoln APPROVED BY [Signature] DATE 4-25-65

INDEX TEST DATA		SPECIMEN DATA		TYPE OF TEST
USCS <u>CL</u>	LL <u>29</u> ; PI <u>12</u>	HEIGHT <u>3.0</u> "	DIAMETER <u>1.0</u> "	UU <input type="checkbox"/> CU <input checked="" type="checkbox"/> CU <input type="checkbox"/> CD <input type="checkbox"/>
% FINER (mm): 0.002 <u>19</u> ; 0.005 <u>23</u> ; 0.074 (#200) <u>64</u>		MATERIALS TESTED PASSED _____ SIEVE		
G _s (#4) <u>2.65</u> ; G _s (#4) _____		METHOD OF PREPARATION <u>Trimmed</u> <u>From undisturbed core</u>		
STANDARD: γ_d MAX. _____ pcf ; w ₀ _____ %		MOLDING MOISTURE _____ %		
MODIFIED: γ_d MAX. _____ pcf ; w ₀ _____ %		MOLDED AT _____ % OF γ_d MAXIMUM		

DRY DENSITY		MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ϵ (%)
INITIAL pcf	CONSOLIDATED pcf	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
1.50	1.54	22.9	79.2	21.4	6.67	10	14.3	2
1.62	1.66	21.7	90.4	19.7	6.15	20	20.7	5
1.61	1.68	22.1	90.6	19.4	6.10	30	37.0	7
1.47	1.53	24.5	80.8	21.6	5.83	15	15.1	5



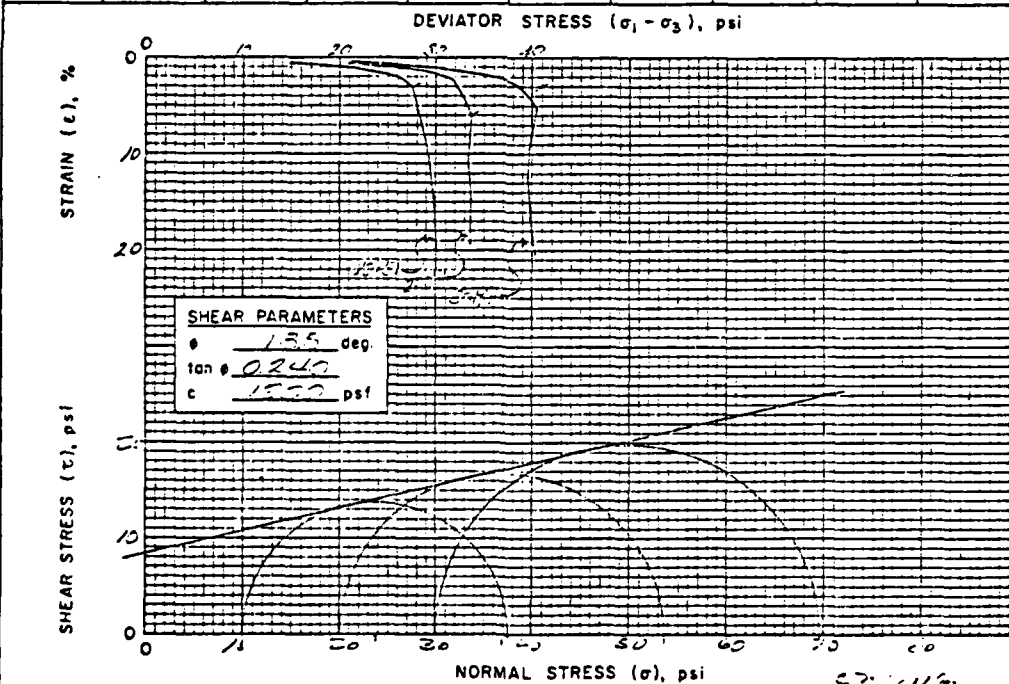
REMARKS SOAKED TO SATURATION

MATERIALS TESTING REPORT U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE TRIAXIAL SHEAR TEST

PROJECT AND STATE: Lincoln County Site No. 10-2, Missouri SAMPLE LOCATION: Borrow
 FIELD SAMPLE NO.: ATK DEPTH: GEOLOGIC ORIGIN: Mix (Alluvial)
 TYPE OF SAMPLE: Compacted TESTED AT: SML, Lincoln APPROVED BY: G. J. J. DATE: 4-26-68

INDEX TEST DATA		SPECIMEN DATA		TYPE OF TEST
USCS	LL	PI	HEIGHT <u>3.0</u> "; DIAMETER <u>1.4</u> "	UU <input type="checkbox"/>
% FINER (mm): 0.002	0.005		MATERIALS TESTED PASSED <u>#4</u> SIEVE	CU <input checked="" type="checkbox"/>
	0.074 (#200)		METHOD OF PREPARATION <u>STATIC 3</u>	CU <input type="checkbox"/>
G _s (-94)	2.63	G _s (+4)	<u>LAYER COMPACTION AND SOAKED</u>	CD <input type="checkbox"/>
STANDARD: γ_d MAX.	111.0 pcf	w ₀	MOLDING MOISTURE <u>17.4</u> %	
MODIFIED: γ_d MAX.		w ₀	MOLDED AT <u>94.9</u> % OF γ_d MAXIMUM	

DRY DENSITY		MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, E (%)
INITIAL pcf	CONSOLIDATED pcf	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
106.3	106.9	16.9	90.9	18.5	4.18	10	27.5	3
106.5	107.1	18.6	91.0	18.2	4.21	20	32.1	6
106.6	107.2	18.5	90.7	17.8	5.15	30	39.6	11



REMARKS: TESTED @ 95.8% STD

MATERIALS TESTING REPORT **U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE** **TRIAxIAL SHEAR TEST**

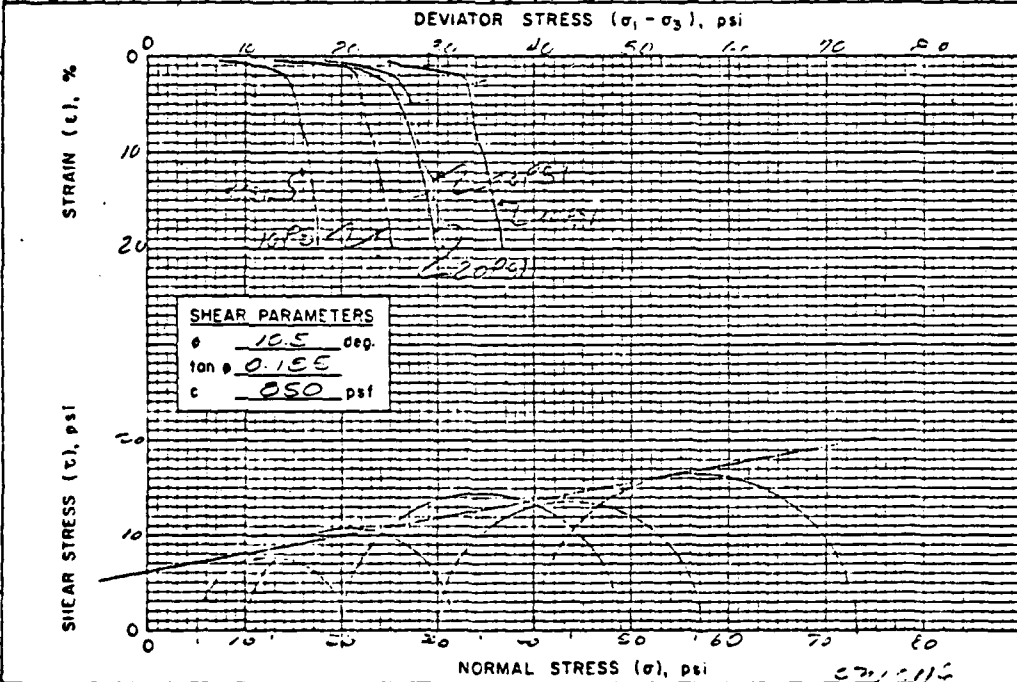
PROJECT AND STATE: Side 2-2, Maryland SAMPLE LOCATION: POYROW 5+00, 12+00

FIELD SAMPLE NO: 107.2 DEPTH: 2.5-9' GEOLOGIC ORIGIN: Glacial Till

TYPE OF SAMPLE: Undisturbed TESTED AT: U.S. Civil Engineer APPROVED BY: H. N. L. DATE: 4-26-68

INDEX TEST DATA			SPECIMEN DATA		TYPE OF TEST
USCS <u>CL</u>	LL <u>40</u>	PI <u>20</u>	HEIGHT <u>3.0</u> "	DIAMETER <u>1.4</u> "	UU <input type="checkbox"/> CU <input checked="" type="checkbox"/> CU <input type="checkbox"/> CD <input type="checkbox"/>
% FINER (mm): 0.002 <u>29</u> ; 0.005 <u>35</u> ; 0.074 (# 200) <u>75</u>			MATERIALS TESTED PASSED # <u>4</u> SIEVE		
G_s (-#4) <u>2.66</u> ; G_s (+#4) _____			METHOD OF PREPARATION <u>STATIC</u> <u>MOLDED IN 3/4" LITE SAND</u>		
STANDARD: γ_d MAX. <u>105.0</u> pcf; w_0 <u>15.5</u> %			MOLDING MOISTURE <u>20.3</u> %		
MODIFIED: γ_d MAX. _____ pcf; w_0 _____ %			MOLDED AT <u>95.2</u> % OF γ_d MAXIMUM		

DRY DENSITY		MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ϵ (%)
INITIAL pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	CONSOLIDATED pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
100.0	100.0	23.3	93.6	23.3	5.92	10	21.5	5.0
100.2	100.5	23.1	92.6	22.8	6.08	20	25.5	14.3
99.4	101.2	23.7	93.7	22.6	5.78	20	22.2	5.0
96.6	99.0	24.6	95.7	24.4	6.60	5	15.3	4.9
100.2	102.4	25.5	95.9	22.2	6.22	40	32.1	30



REMARKS AVERAGE TEST $\phi = 95.1$ % STD.

MATERIALS TESTING REPORT		U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		COMPACTION AND PENETRATION RESISTANCE	
PROJECT OR STATE <u>Parthar Creek #C-2, Missouri</u>					
FIELD SAMPLE NO. <u>202.1</u>		LOCATION <u>E. Emer. Spring, 100' N. 4+00</u>			DEPTH <u>0.5'-10'</u>
GEOLOGIC ORIGIN <u>Glacial Till</u>		TESTED AT <u>S.M.L. Lincoln</u>		APPROVED BY <u>H. N. L.</u>	DATE <u>4-26-68</u>
CLASSIFICATION <u>CH</u> LL <u>51</u> PI <u>30</u>		CURVE NO. <u>1</u> OF <u>6</u>			
MAX. PARTICLE SIZE INCLUDED IN TEST <u>< # 4</u>		STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>1</u>			
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 <u>2.72</u>		MOD. (ASTM D-1557) <input type="checkbox"/> METHOD <u> </u>			
		OTHER TEST <input type="checkbox"/> (SEE REMARKS)			

PENETRATION RESISTANCE, psi

DENSITY OF COMPACTED SOIL, pcf

MAX. γ_d 101.0 pcf

OPT. MOIST. 15.5 %

NATURAL MOIST. %

MOISTURE CONTENT, PERCENT OF DRY WEIGHT

REMARKS

MATERIALS U.S. DEPARTMENT OF AGRICULTURE
 TESTING REPORT SOIL CONSERVATION SERVICE COMPACTION AND
 PENETRATION RESISTANCE

PROJECT AND STATE Griffin Creek # C-2, Missouri

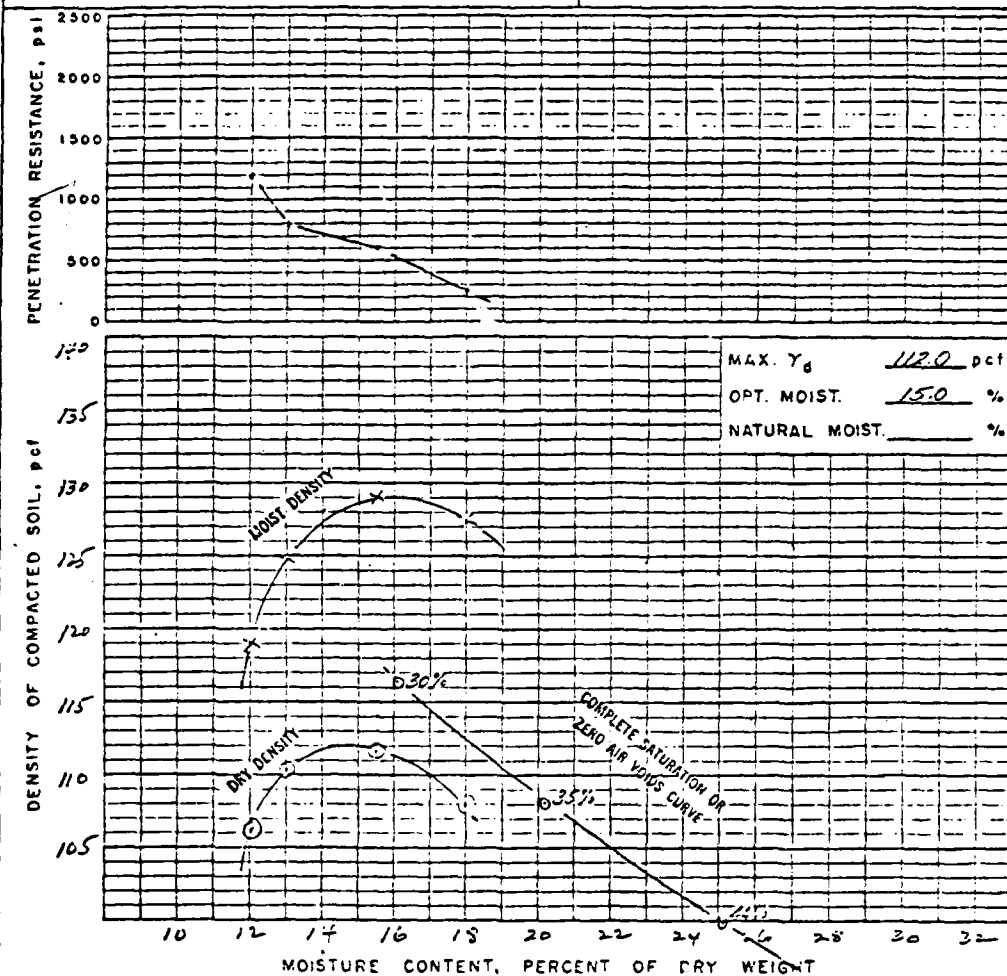
FIELD SAMPLE NO. 1011 LOCATION Barrow, A-75, E-85 DEPTH 0-2.5'

GEO. SEC. OR GR. Griffin Till TESTED AT S.M.L. Lincoln APPROVED BY J.C. 5 DATE 4-24-68

CLASSIFICATION CL LL 34 PI 18 CURVE NO. 2 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST < #4 STD. (ASTM D-698) ☒ METHOD A

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.66 MOD. (ASTM D-1557) ☐ METHOD
PLUS NO. 4 OTHER TEST ☐ (SEE REMARKS)



MAX. Y_d 112.0 pcf
 OPT. MOIST. 15.0 %
 NATURAL MOIST. %

REMARKS

MATERIALS TESTING REPORT U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE COMPACTION AND PENETRATION RESISTANCE

PROJECT NO. STATE Panther Creek # C-2, Missouri

FIELD SAMPLE NO. Composite LOCATION Borrow Composite DEPTH 0-6'

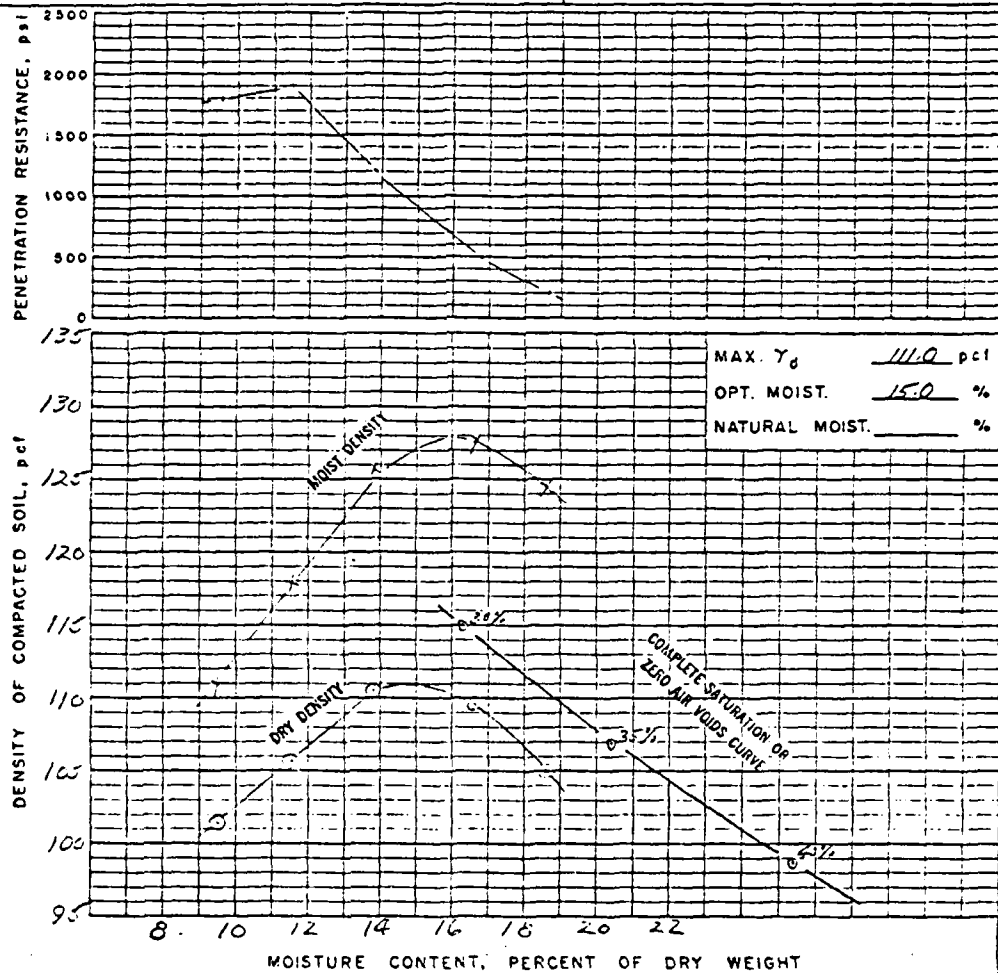
GEOLOGIC FORM Mix (Alluvial) TESTED AT S.M.L. Lincoln APPROVED BY J. C. K. DATE 4-26-65

CLASSIFICATION CL LL PI CURVE NO. 3 OF 6

MAX. PARTICLE SIZE INCLUDED IN TEST #4 STD. (ASTM D-698) ☒ METHOD A

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.63 MOD. (ASTM D-1557) ☐ METHOD

{ PLUS NO. 4 OTHER TEST ☐ (SEE REMARKS)



MAX. γ_d 111.0 pcf
 OPT. MOIST. 15.0 %
 NATURAL MOIST. %

REMARKS

MATERIALS		U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		COMPACTION AND PENETRATION RESISTANCE	
PROJECT OR SITE <u>Parthen Creek # C-2 Missouri</u>					
FIELD SAMPLE NO. <u>125.2 & 125.1</u>	LOCATION <u>Barren Composit</u>	DT+50, 1+00 = 105.1 C+50 2+00 = 105.1		DEPTH <u>2-E</u>	<u>2-10</u>
GEOLOGIC ORIGIN <u>Alluvium</u>	TESTED AT <u>C.M.L. Lincoln</u>	APPROVED BY <u>B. J. J.</u>	DATE <u>4-26-68</u>		
CLASSIFICATION <u>CL</u> LL <u> </u> PI <u> </u>			CURVE NO. <u>4</u> OF <u>6</u>		
MAX. PARTICLE SIZE INCLUDED IN TEST <u>< # 4</u>			STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>2</u>		
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 <u>2.66</u>			MOD. (ASTM D-1557) <input type="checkbox"/> METHOD <u> </u>		
			OTHER TEST <input type="checkbox"/> (SEE REMARKS)		
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p style="text-align: center;">PENETRATION RESISTANCE, PSI</p> </div> <div style="width: 35%;"> <p>MAX. γ_d <u>118.5</u> pcf</p> <p>OPT. MOIST. <u>15.0</u> %</p> <p>NATURAL MOIST. <u> </u> %</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="width: 60%;"> <p style="text-align: center;">DENSITY OF COMPACTED SOIL, pcf</p> </div> <div style="width: 35%;"></div> </div> <p style="text-align: center;">MOISTURE CONTENT, PERCENT OF DRY WEIGHT</p>					
REMARKS					

MATERIALS TESTING REPORT		U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		COMPACTION AND PENETRATION RESISTANCE	
PROJECT OR STATE <u>Panther Creek "C-2", Missouri</u>					
FIELD SAMPLE NO. <u>1071</u>		LOCATION <u>Barrow, E-22 12+00</u>		DEPTH <u>0-3.5</u>	
GEOLOGIC ORIGIN <u>Glacial Till derived</u>		TESTED AT <u>C.M.L. Lirich</u>		APPROVED BY <u>N.H. G.</u>	
DATE <u>4-26-67</u>					
CLASSIFICATION <u>CL</u> LL <u>35</u> PI <u>17</u>		CURVE NO. <u>5</u> OF <u>6</u>			
MAX. PARTICLE SIZE INCLUDED IN TEST <u>4 # 4</u>		STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>A</u>			
SPECIFIC GRAVITY (G _s) { MINUS NO. 4 <u>2.63</u>		MOD. (ASTM D-1557) <input type="checkbox"/> METHOD <u> </u>			
		OTHER TEST <input type="checkbox"/> (SEE REMARKS)			

PENETRATION RESISTANCE, pcf

DENSITY OF COMPACTED SOIL, pcf

MAX. γ_d 106.0 pcf

OPT. MOIST. 17.0 %

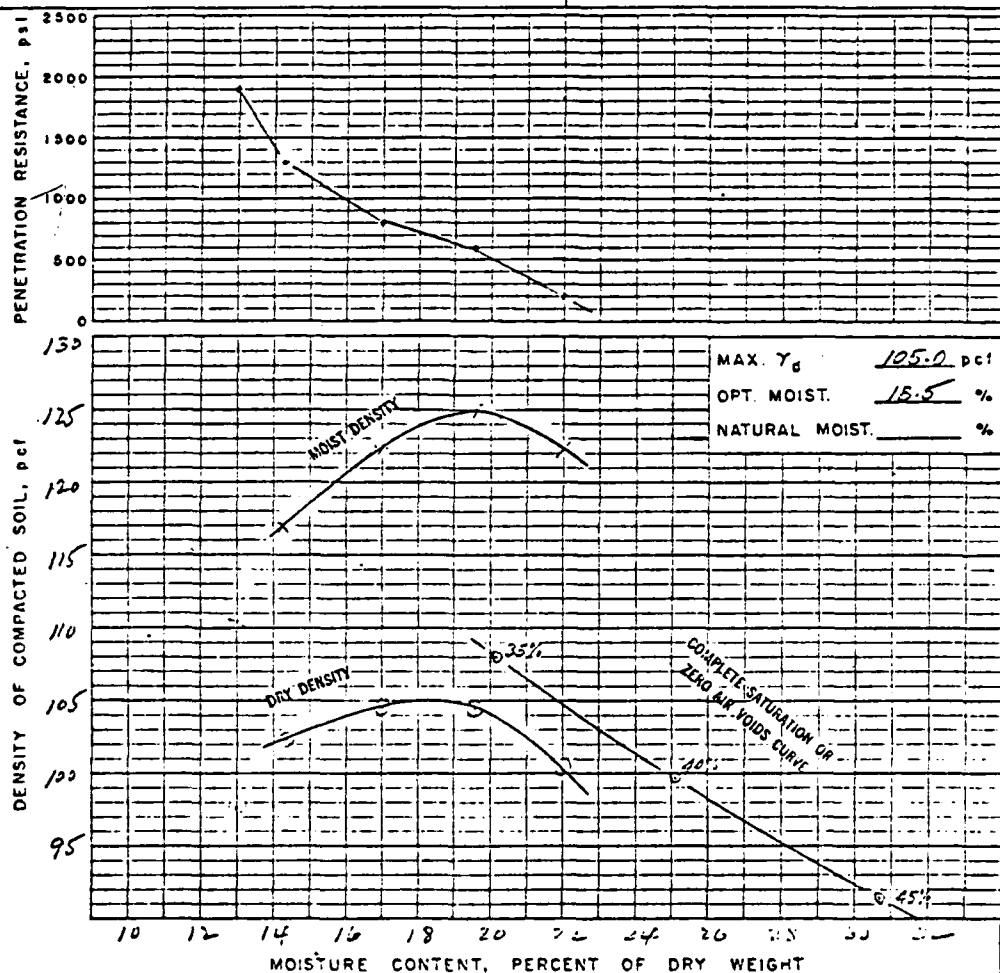
NATURAL MOIST. %

MOISTURE CONTENT, PERCENT OF DRY WEIGHT

REMARKS

68001772

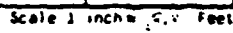
MATERIALS		U.S. DEPARTMENT OF AGRICULTURE		COMPACTION AND	
TESTING REPORT		SOIL CONSERVATION SERVICE		PENETRATION RESISTANCE	
PROJECT OR STATE <u>Panther Creek "C-2", Missouri</u>					
FIELD SAMPLE NO. <u>1072</u>		LOCATION <u>Barren, E+00 12+00</u>			DEPTH <u>15'-8"</u>
GEOLOGIC ORIGIN <u>Glacial Till</u>		TESTED AT <u>S.M.L. Lincoln</u>		APPROVED BY <u>[Signature]</u>	DATE <u>4-26-68</u>
CLASSIFICATION <u>CL</u>		LL <u>40</u> PI <u>20</u>		CURVE NO. <u>6</u> OF <u>6</u>	
MAX. PARTICLE SIZE INCLUDED IN TEST <u>≤ #4</u>				STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>A</u>	
SPECIFIC GRAVITY (G _s) { MINUS NO. 4 <u>2.66</u>				MOD. (ASTM D-1557) <input type="checkbox"/> METHOD _____	
				OTHER TEST <input type="checkbox"/> (SEE REMARKS)	

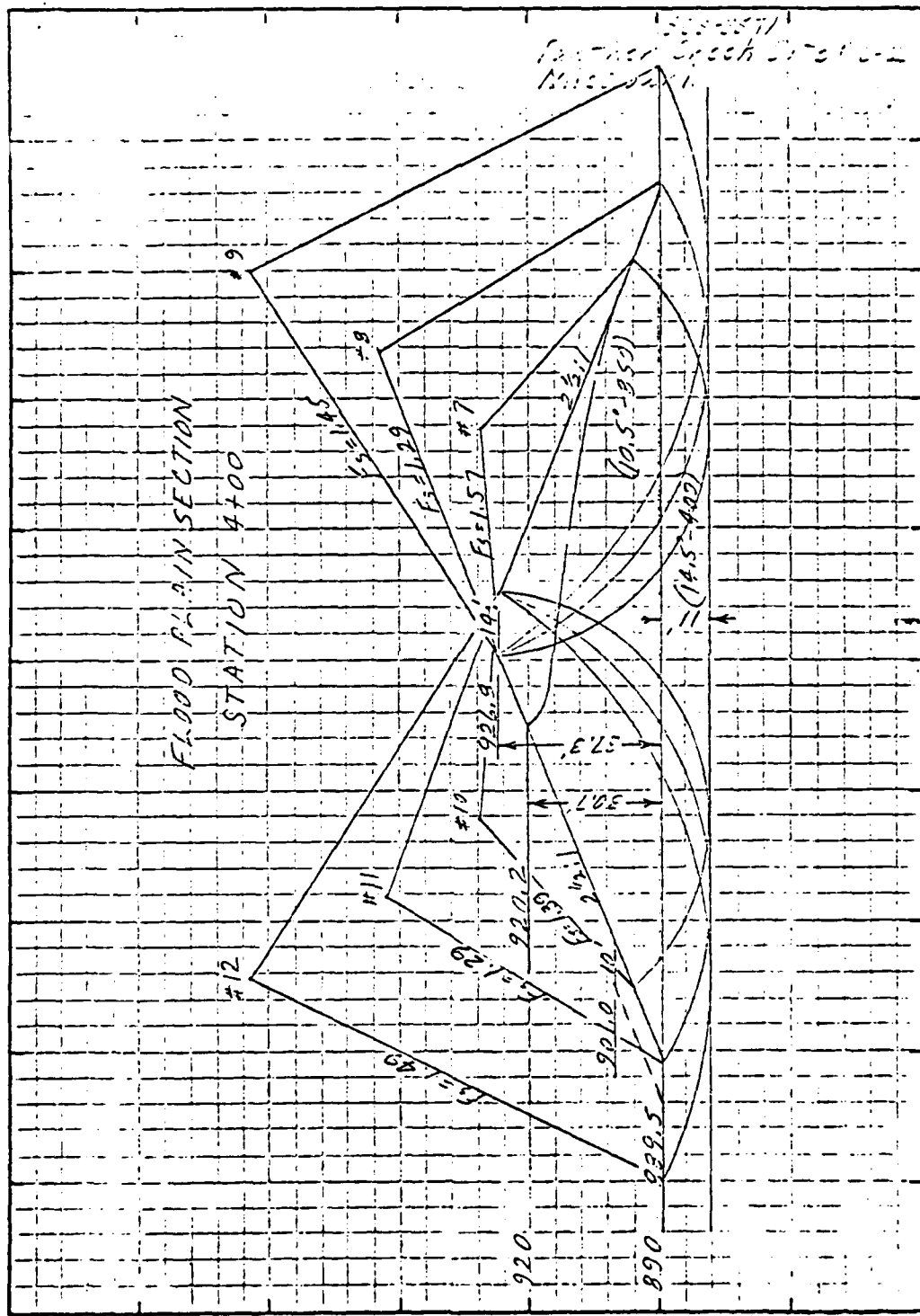


REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		SUMMARY - SLOPE STABILITY ANALYSIS		
PROJECT AND STATE				DATE		
METHOD OF ANALYSIS				ANALYZED AT		
APPROVED BY						
SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA				REMARKS
		γ_d (pcf)	γ_{sat} (pcf)	ϕ (deg)	c (psf)	
① Embank.	CL	97.0	119.0	56.5	0.253	402
② Embank.	CL	99.7	118.0	123.0	0.185	850
③ Embank.	CL	106.5	122.5	126.5	0.340	1202
④						
⑤						
⑥						
⑦						
⑧						
MAXIMUM SECTION @ STATION 6+25						
1	2 1/2:1	Full depth - No berm - Arc cut from opp. shldr. thru emb. (12.5'-352) only				1.60
2	2 1/2:1	Same conditions as trial #1				1.23
3	2 1/2:1	Same conditions as trial #1				1.70
4	2 1/2:1	No berm - No berm - Arc cut from opp. shldr. thru emb. (12.5'-952) only				1.73
5	2 1/2:1	Same conditions as trial #1				1.66
6	2 1/2:1	Same conditions as trial #1				1.92
FLOOD PLAIN SECTION @ STATION 4+00						
7	2 1/2:1	No berm - No berm - Arc cut from opp. shldr. thru emb. (10.5'-952) full depth (14.5'-900)				1.57
8	2 1/2:1	Same conditions as trial #1				1.20
9	2 1/2:1	Same conditions as trial #1				1.45
10	2 1/2:1	Full depth - No berm - Arc cut from opp. shldr. thru emb. (10.5'-952) full depth (14.5'-900)				1.40
11	2 1/2:1	Same conditions as trial #10				1.29
12	2 1/2:1	Same conditions as trial #10				1.32

100-357





STRUCTURE DATA

Class of Structure "a" Floodwater Retarding

Drainage Area (total) 5031 Ac. 211 Sq. Mi.

(uncontrolled) 1495 Ac. 702 Sq. Mi.

Time of Concentration 2.21 Hours

Soil Cover Complex Number 78 For A.M.C. II

Sediment Capacity Available 476 Ac. Ft. below Elev. 906.5

Total Sediment Capacity Available 476 Ac. Ft.

Capacity Equivalents (Vol.) 1.27 In.

Retarding Capacity Provided 1510 Ac. Ft.

Capacity Equivalents (Vol.) 4.05 In.

Water Supply Provided Ac. Ft. - Identity Uses

Principal Spillway:

Maximum Capacity (uncontrolled) 339 c.f.s.

10 Day Drainage Elev. 906.5

Emergency Spillway:

Percent Chance Use 2 Storm Duration 6 Hours

Veg. Earth-Less Channel

Type Rock-Inlet Channel "n" Value Used 0.04

Emergency Spillway Hydrograph for Class 6 Structures

Rainfall 7.90 in.

Runoff 5.31 in.

Peak Inflow 7237 c.f.s.

Maximum Discharge - Emergency Spillway 710 c.f.s.

Maximum Water Surface Elev. 922.2

Velocity of Flow (Vel) 5.7 f.p.s.

Supplementary Data and Special Design Features:

① Based on uncontrolled drainage area

② The following conditions existed:

a. Emergency Spillway Routing considered

b. Structure B-13, B-10, and B-11 in place.

c. Freeboard Routing considered total

d. drainage area, uncontrolled.

③ Taken from Composite Hydrograph.

② Freeboard Hydrograph for Class 6 Structures:

Rainfall 13.70 in.

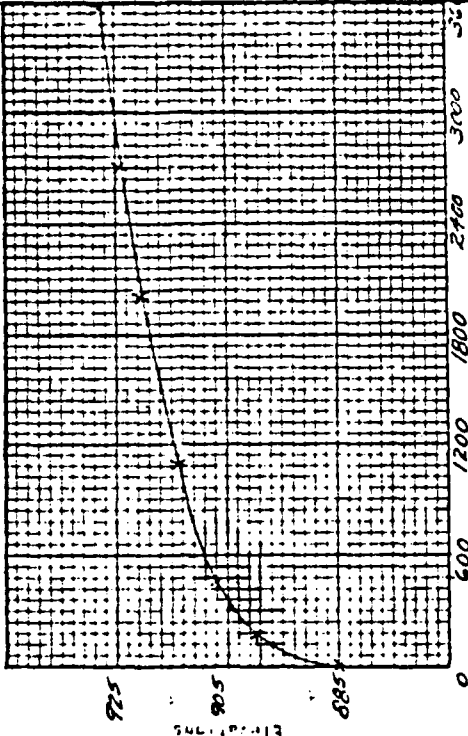
Runoff 10.83 in.

Peak Inflow 18,516 c.f.s.

Maximum Discharge - Emergency Spillway 8774 c.f.s.

Maximum Water Surface Elev. 922.9

Reservoir Capacity



Total Storage - Ac. Ft.

AS BUILT

10-3-72

STRUCTURE C-2

PANTHER CREEK WATERSHED PL. 566

HARRISON COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

NO. 8 R.M. 1959

U.S. 1949

PL. 566

PL. 27,029-E

Supplementary Data and Special Design Features:

1. The Emergency Spillway inlet channel

was routed with a 0.00 slope.

A 0.005 slope was used.

2 Principal Spillway Crest Elev. 906.5

3 Emergency Spillway Crest Elev. 920.2

4 Emergency Spillway Bottom Width = 180'

5 Settled Top of Dam Elev. 927.9

H.S. = 34.2 x 1994 = 78.165

51	5189.	93.	96.	100.	103.	107.6	112.7	115.8	118.	120.
52	5192.									
53	5118.7									
54	510.0	20.	585.							
55	5118.7	118.9	119.5							
56	5110.	0.5	92.	1.	112.	118.7				
57	K	1	6							
58	RT CHANNEL ROUTING TO STRUCTURE C-2									
59	V	1								
60	V1	1								
61	760.04	0.05	0.04	88.2	119.	4167.	0.0055			
62	770.0	117.	410.	100.6	95.3	470.				
63	77495.	98.	510.	98.6	119.					
64	K	7								
65	RT CALCULATE JMWELCH HYDROGRAPH TO B-10									
66	M	1	2	1.008	1.0					
67	P	1	23.9	101.	170.	130.				
68	T									
69	W2	0.318								
70	X	1.								
71	K	1								
72	RT ROUTE HYDROGRAPH THROUGH STRUCTURE B-10 (NO.10.#10072)									
73	V	1								
74	V1	1								
75	74122.	122.5	123.	123.5	124.	124.5	125.	125.75	126.8	127.8
76	74128.8	129.8	130.8	131.8	132.8					
77	750.9	73.	74.	75.	76.	77.	78.	79.	80.	120.
78	75404.	711.	1161.	1781.	2431.					
79	7530.0	37.	60.	91.	128.	169.	219.	278.	314.	350.
80	75108.	114.	116.8	120.	122.	124.	126.	128.	129.	130.
81	75112.									
82	75129.1									
83	7510.0	50.	690.							
84	75129.1	129.2	129.9							
85	75115.	0.5	108.	1.	122.	129.1				
86	K	1								
87	RT CHANNEL ROUTING TO STRUCTURE C-2									
88	V	1								
89	V1	1								
90	760.06	0.05	0.06	98.	130.	5670.	0.0060			
91	770.0	120.	315.	109.	445.	100.	465.	98.	490.	98.
92	77500.	110.	593.	114.	740.	130.				
93	K	10								
94	RT CALCULATE INFLOW HYDROGRAPH TO UNCONTROLLED AREA OF WEST ARM OF C-2									
95	M	1	2	2.758	1.0					
96	P	1	23.9	101.	170.	130.				
97	T									
98	W2	0.674								
99	X	1.								
100	K	1								

BLACKE V E A Y C H

FLOOD HYDROGRAPH PACKAGE - MEC-1

[illegible]

UNIT HYDROGRAPH DATA
-CO LAG= 1.73

BLACK & VEATCH

FLOOD HYDROGRAPH PACKAGE - NEC-1

[illegible]

TIME	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
1.01 8.00	56	904	1.01 20.00	241	2560
1.01 8.05	57	1035	1.01 20.05	241	2560
1.01 8.10	58	1074	1.01 20.10	242	2560
1.01 8.15	59	1110	1.01 20.15	243	2560
1.01 8.20	60	1147	1.01 20.20	244	2560
1.01 8.25	61	1183	1.01 20.25	245	2560
1.01 8.30	62	1219	1.01 20.30	246	2560
1.01 8.35	63	1256	1.01 20.35	247	2560
1.01 8.40	64	1292	1.01 20.40	248	2560
1.01 8.45	65	1329	1.01 20.45	249	2560
1.01 8.50	66	1365	1.01 20.50	250	2560
1.01 8.55	67	1401	1.01 20.55	251	2560
1.01 9.00	68	1437	1.01 21.00	252	2560
1.01 9.05	69	1473	1.01 21.05	253	2560
1.01 9.10	70	1509	1.01 21.10	254	2560
1.01 9.15	71	1545	1.01 21.15	255	2560
1.01 9.20	72	1581	1.01 21.20	256	2560
1.01 9.25	73	1617	1.01 21.25	257	2560
1.01 9.30	74	1653	1.01 21.30	258	2560
1.01 9.35	75	1689	1.01 21.35	259	2560
1.01 9.40	76	1725	1.01 21.40	260	2560
1.01 9.45	77	1761	1.01 21.45	261	2560
1.01 9.50	78	1797	1.01 21.50	262	2560
1.01 9.55	79	1833	1.01 21.55	263	2560
1.01 10.00	80	1869	1.01 22.00	264	2560
1.01 10.05	81	1905	1.01 22.05	265	2560
1.01 10.10	82	1941	1.01 22.10	266	2560
1.01 10.15	83	1977	1.01 22.15	267	2560
1.01 10.20	84	2013	1.01 22.20	268	2560
1.01 10.25	85	2049	1.01 22.25	269	2560
1.01 10.30	86	2085	1.01 22.30	270	2560
1.01 10.35	87	2121	1.01 22.35	271	2560
1.01 10.40	88	2157	1.01 22.40	272	2560
1.01 10.45	89	2193	1.01 22.45	273	2560
1.01 10.50	90	2229	1.01 22.50	274	2560
1.01 10.55	91	2265	1.01 22.55	275	2560
1.01 11.00	92	2301	1.01 23.00	276	2560
1.01 11.05	93	2337	1.01 23.05	277	2560
1.01 11.10	94	2373	1.01 23.10	278	2560
1.01 11.15	95	2409	1.01 23.15	279	2560
1.01 11.20	96	2445	1.01 23.20	280	2560
1.01 11.25	97	2481	1.01 23.25	281	2560
1.01 11.30	98	2517	1.01 23.30	282	2560
1.01 11.35	99	2553	1.01 23.35	283	2560
1.01 11.40	100	2589	1.01 23.40	284	2560
1.01 11.45	101	2625	1.01 23.45	285	2560
1.01 11.50	102	2661	1.01 23.50	286	2560
1.01 11.55	103	2697	1.01 23.55	287	2560
1.01 12.00	104	2733	1.02	288	2560

SUM 31.07 25.78 1.29 80254.
 (789.3) (756.3) (33.3) (22600.67)
 PEAK 14648.
 CFS 415.
 6-HOUR 2477.
 24-HOUR 2778.
 72-HOUR 2778.
 TOTAL VOLUME 789577.
 22655.

TIME	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
4720.	4802.	5019.	5707.	5555.
4800.	4871.	4935.	5746.	5591.
4840.	4940.	5005.	5780.	5627.
4900.	5008.	5075.	5815.	5663.
4940.	5075.	5143.	5850.	5699.
5000.	5143.	5211.	5885.	5735.
5040.	5211.	5279.	5920.	5771.
5100.	5279.	5347.	5955.	5807.
5140.	5347.	5415.	5990.	5843.
5200.	5415.	5483.	6025.	5879.
5240.	5483.	5551.	6060.	5915.
5300.	5551.	5619.	6095.	5951.
5340.	5619.	5687.	6130.	5987.
5400.	5687.	5755.	6165.	6023.
5440.	5755.	5823.	6200.	6059.
5500.	5823.	5891.	6235.	6095.
5540.	5891.	5959.	6270.	6131.
5600.	5959.	6027.	6305.	6167.
5640.	6027.	6095.	6340.	6203.
5700.	6095.	6163.	6375.	6239.
5740.	6163.	6231.	6410.	6275.
5800.	6231.	6299.	6445.	6311.
5840.	6299.	6367.	6480.	6347.
5900.	6367.	6435.	6515.	6383.
5940.	6435.	6503.	6550.	6419.
6000.	6503.	6571.	6585.	6455.
6040.	6571.	6639.	6620.	6491.
6100.	6639.	6707.	6655.	6527.
6140.	6707.	6775.	6690.	6563.
6200.	6775.	6843.	6725.	6599.
6240.	6843.	6911.	6760.	6635.
6300.	6911.	6979.	6795.	6671.
6340.	6979.	7047.	6830.	6707.
6400.	7047.	7115.	6865.	6743.
6440.	7115.	7183.	6900.	6779.
6500.	7183.	7251.	6935.	6815.
6540.	7251.	7319.	6970.	6851.
6600.	7319.	7387.	7005.	6887.
6640.	7387.	7455.	7040.	6923.
6700.	7455.	7523.	7075.	6959.
6740.	7523.	7591.	7110.	6995.
6800.	7591.	7659.	7145.	7031.
6840.	7659.	7727.	7180.	7067.
6900.	7727.	7795.	7215.	7103.
6940.	7795.	7863.	7250.	7139.
7000.	7863.	7931.	7285.	7175.
7040.	7931.	7999.	7320.	7211.
7100.	7999.	8067.	7355.	7247.
7140.	8067.	8135.	7390.	7283.
7200.	8135.	8203.	7425.	7319.
7240.	8203.	8271.	7460.	7355.
7300.	8271.	8339.	7495.	7391.
7340.	8339.	8407.	7530.	7427.
7400.	8407.	8475.	7565.	7463.
7440.	8475.	8543.	7600.	7499.
7500.	8543.	8611.	7635.	7535.
7540.	8611.	8679.	7670.	7571.
7600.	8679.	8747.	7705.	7607.
7640.	8747.	8815.	7740.	7643.
7700.	8815.	8883.	7775.	7679.
7740.	8883.	8951.	7810.	7715.
7800.	8951.	9019.	7845.	7751.
7840.	9019.	9087.	7880.	7787.
7900.	9087.	9155.	7915.	7823.
7940.	9155.	9223.	7950.	7859.
8000.	9223.	9291.	7985.	7895.
8040.	9291.	9359.	8020.	7931.
8100.	9359.	9427.	8055.	7967.
8140.	9427.	9495.	8090.	8003.
8200.	9495.	9563.	8125.	8039.
8240.	9563.	9631.	8160.	8075.
8300.	9631.	9699.	8195.	8111.
8340.	9699.	9767.	8230.	8147.
8400.	9767.	9835.	8265.	8183.
8440.	9835.	9903.	8300.	8219.
8500.	9903.	9971.	8335.	8255.
8540.	9971.	10039.	8370.	8291.
8600.	10039.	10107.	8405.	8327.
8640.	10107.	10175.	8440.	8363.
8700.	10175.	10243.	8475.	8399.
8740.	10243.	10311.	8510.	8435.
8800.	10311.	10379.	8545.	8471.
8840.	10379.	10447.	8580.	8507.
8900.	10447.	10515.	8615.	8543.
8940.	10515.	10583.	8650.	8579.
9000.	10583.	10651.	8685.	8615.
9040.	10651.	10719.	8720.	8651.
9100.	10719.	10787.	8755.	8687.
9140.	10787.	10855.	8790.	8723.
9200.	10855.	10923.	8825.	8759.
9240.	10923.	10991.	8860.	8795.
9300.	10991.	11059.	8895.	8831.
9340.	11059.	11127.	8930.	8867.
9400.	11127.	11195.	8965.	8903.
9440.	11195.	11263.	9000.	8939.
9500.	11263.	11331.	9035.	8975.
9540.	11331.	11399.	9070.	9011.
9600.	11399.	11467.	9105.	9047.
9640.	11467.	11535.	9140.	9083.
9700.	11535.	11603.	9175.	9119.
9740.	11603.	11671.	9210.	9155.
9800.	11671.	11739.	9245.	9191.
9840.	11739.	11807.	9280.	9227.
9900.	11807.	11875.	9315.	9263.
9940.	11875.	11943.	9350.	9299.
10000.	11943.	12011.	9385.	9335.

TIME	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
4720.	4802.	5019.	5707.	5555.
4800.	4871.	4935.	5746.	5591.
4840.	4940.	5005.	5780.	5627.
4900.	5008.	5075.	5815.	5663.
4940.	5075.	5143.	5850.	5699.
5000.	5143.	5211.	5885.	5735.
5040.	5211.	5279.	5920.	5771.
5100.	5279.	5347.	5955.	5807.
5140.	5347.	5415.	5990.	5843.
5200.	5415.	5483.	6025.	5879.
5240.	5483.	5551.	6060.	5915.
5300.	5551.	5619.	6095.	5951.
5340.	5619.	5687.	6130.	5987.
5400.	5687.	5755.	6165.	6023.
5440.	5755.	5823.	6200.	6059.
5500.	5823.	5891.	6235.	6095.
5540.	5891.	5959.	6270.	6131.
5600.	5959.	6027.	6305.	6167.
5640.	6027.	6095.	6340.	6203.
5700.	6095.	6163.	6375.	6239.
5740.	6163.	6231.	6410.	6275.
5800.	6231.	6299.	6445.	6311.
5840.	6299.	6367.	6480.	6347.
5900.	6367.	6435.	6515.	6383.
5940.	6435.	6503.	6550.	6419.
6000.	6503.	6571.	6585.	6455.
6040.	6571.	6639.	6620.	6491.
6100.	6639.	6707.	6655.	6527.
6140.	6707.	6775.	6690.	6563.
6200.	6775.	6843.	6725.	6599.
6240.	6843.	6911.	6760.	6635.
6300.	6911.	6979.	6795.	6671.
6340.	6979.	7047.	6830.	6707.
6400.	7047.	7115.	6865.	6743.
6440.	7115.	7183.	6900.	6779.
6500.	7183.	7251.	6935.	6815.
6540.	7251.	7319.	6970.	6851.
6600.	7319.	7387.	7005.	6887.
6640.	7387.	7455.	7040.	6923.
6700.	7455.	7523.	7075.	6959.
6740.	7523.	7591.	7110.	6995.
6800.	7591.	7659.	7145.	7031.
6840.	7659.	7727.	7180.	7067.
6900.	7727.	7795.	7215.	7103.
6940.	7795.	7863.	7250.	7139.
7000.	7863.	7931.	7285.	7175.
7040.	7931.	7999.	7320.	7211.
7100.	7999.	8067.	7355.	7247.
7140.	8067.	8135.	7390.	7283.
7200.	8135.	8203.	7425.	7319.
7240.	8203.	8271.	7460.	7355.
7300.	8271.	8339.	7495.	7391.
7340.	8339.	8407.	7530.	7427.
7400.	8407.	8475.	7565.	7463.
7440.	8475.	8543.	7600.	7499.
7500.	8543.	8611.	7635.	7535.
7540.	8611.	8679.	7670.	7571.
7600.	8679.	8747.	7705.	7607.
7640.	8747.	8815.	7740.	7643.
7700.	8815.	8883.	7775.	7679.
7740.	8883.	8951.	7810.	7715.
7800.	8951.	9019.	7845.	7751.
7840.	9019.	9087.	7880.	7787.
7900.	9087.	9155.	7915.	7823.
7940.	9155.	9223.	7950.	7859.
8000.	9223.	9291.	7985.	7895.
8040.	9291.	9359.	8020.	7931.
8100.	9359.	9427.	8055.	7967.
8140.	9427.	9495.	8090.	8003.
8200.	9495.	9563.	8125.	8039.
8240.	9563.	9631.	8160.	8075.
8300.	9631.	9699.	8195.	8111.
8340.	9699.	9767.	8230.	8147.
8400.	9767.	9835.	8265.	8183.
8440.	9835.	9903.	8300.	8219.
8500.	9903.	9971.	8335.	8255.
8540.	9971.	10039.	8370.	8291.
8600.	10039.	10107.	8405.	8327.
8640.	10107.	10175.	8440.	8363.
8700.	10175.	10243.	8475.	8399.
8740.	10243.	10311.	8510.	8435.
8800.	10311.	10379.	8545.	8471.
8840.	10379.	10447.	8580.	8507.
8900.	10447.	10515.	8615.	8543.
8940.	10515.	10583.	8650.	8579.
9000.	10583.	10651.	8685.	8615.
9040.	10651.	10719.	8720.	8651.
9100.	10719.	10787.	8755.	8687.
9140.	10787.	10855.	8790.	8723.
9200.	10855.	10923.	8825.	8759.
9240.	10923.	10991.	8860.	8795.
9300.	10991.	11059.	8895.	8831.
9340.	11059.	11127.	8930.	8867.
9400.	11127.	11195.	8965.	8903.
9440.	11195.	11263.	9000.	8939.
9500.	11263.	11331.	9035.	8975.
9540.	11331.	11399.	9070.	9011.
9600.	11399.	11467.	9105.	9047.
9640.	11467.	11535.	9140.	9083.
9700.	11535.	11603.	9175.	9119.
9740.	11603.	11671.	9210.	9155.
9800.	11671.	11739.	9245.	9191.
9840.	11739.	11807.	9280.	9227.
9900.	11807.	11875.	9315.	9263.
9940.	11875.	11943.	9350.	9299.
10000.	11943.	12011.	9385.	9335.

40.	45.	50.	55.	60.	65.	70.	75.	80.	85.	90.	95.	100.	105.	110.	115.	120.
131.	141.	151.	161.	171.	181.	191.	201.	211.	221.	231.	241.	251.	261.	271.	281.	291.
301.	311.	321.	331.	341.	351.	361.	371.	381.	391.	401.	411.	421.	431.	441.	451.	461.
471.	481.	491.	501.	511.	521.	531.	541.	551.	561.	571.	581.	591.	601.	611.	621.	631.
641.	651.	661.	671.	681.	691.	701.	711.	721.	731.	741.	751.	761.	771.	781.	791.	801.
811.	821.	831.	841.	851.	861.	871.	881.	891.	901.	911.	921.	931.	941.	951.	961.	971.
981.	991.	1001.	1011.	1021.	1031.	1041.	1051.	1061.	1071.	1081.	1091.	1101.	1111.	1121.	1131.	1141.
1151.	1161.	1171.	1181.	1191.	1201.	1211.	1221.	1231.	1241.	1251.	1261.	1271.	1281.	1291.	1301.	1311.
1321.	1331.	1341.	1351.	1361.	1371.	1381.	1391.	1401.	1411.	1421.	1431.	1441.	1451.	1461.	1471.	1481.
1491.	1501.	1511.	1521.	1531.	1541.	1551.	1561.	1571.	1581.	1591.	1601.	1611.	1621.	1631.	1641.	1651.
1661.	1671.	1681.	1691.	1701.	1711.	1721.	1731.	1741.	1751.	1761.	1771.	1781.	1791.	1801.	1811.	1821.
1831.	1841.	1851.	1861.	1871.	1881.	1891.	1901.	1911.	1921.	1931.	1941.	1951.	1961.	1971.	1981.	1991.
2001.	2011.	2021.	2031.	2041.	2051.	2061.	2071.	2081.	2091.	2101.	2111.	2121.	2131.	2141.	2151.	2161.
2171.	2181.	2191.	2201.	2211.	2221.	2231.	2241.	2251.	2261.	2271.	2281.	2291.	2301.	2311.	2321.	2331.
2341.	2351.	2361.	2371.	2381.	2391.	2401.	2411.	2421.	2431.	2441.	2451.	2461.	2471.	2481.	2491.	2501.
2511.	2521.	2531.	2541.	2551.	2561.	2571.	2581.	2591.	2601.	2611.	2621.	2631.	2641.	2651.	2661.	2671.
2681.	2691.	2701.	2711.	2721.	2731.	2741.	2751.	2761.	2771.	2781.	2791.	2801.	2811.	2821.	2831.	2841.
2851.	2861.	2871.	2881.	2891.	2901.	2911.	2921.	2931.	2941.	2951.	2961.	2971.	2981.	2991.	3001.	3011.
3021.	3031.	3041.	3051.	3061.	3071.	3081.	3091.	3101.	3111.	3121.	3131.	3141.	3151.	3161.	3171.	3181.
3191.	3201.	3211.	3221.	3231.	3241.	3251.	3261.	3271.	3281.	3291.	3301.	3311.	3321.	3331.	3341.	3351.
3361.	3371.	3381.	3391.	3401.	3411.	3421.	3431.	3441.	3451.	3461.	3471.	3481.	3491.	3501.	3511.	3521.
3531.	3541.	3551.	3561.	3571.	3581.	3591.	3601.	3611.	3621.	3631.	3641.	3651.	3661.	3671.	3681.	3691.
3701.	3711.	3721.	3731.	3741.	3751.	3761.	3771.	3781.	3791.	3801.	3811.	3821.	3831.	3841.	3851.	3861.
3871.	3881.	3891.	3901.	3911.	3921.	3931.	3941.	3951.	3961.	3971.	3981.	3991.	4001.	4011.	4021.	4031.
4041.	4051.	4061.	4071.	4081.	4091.	4101.	4111.	4121.	4131.	4141.	4151.	4161.	4171.	4181.	4191.	4201.
4211.	4221.	4231.	4241.	4251.	4261.	4271.	4281.	4291.	4301.	4311.	4321.	4331.	4341.	4351.	4361.	4371.
4381.	4391.	4401.	4411.	4421.	4431.	4441.	4451.	4461.	4471.	4481.	4491.	4501.	4511.	4521.	4531.	4541.
4551.	4561.	4571.	4581.	4591.	4601.	4611.	4621.	4631.	4641.	4651.	4661.	4671.	4681.	4691.	4701.	4711.
4721.	4731.	4741.	4751.	4761.	4771.	4781.	4791.	4801.	4811.	4821.	4831.	4841.	4851.	4861.	4871.	4881.
4891.	4901.	4911.	4921.	4931.	4941.	4951.	4961.	4971.	4981.	4991.	5001.	5011.	5021.	5031.	5041.	5051.
5061.	5071.	5081.	5091.	5101.	5111.	5121.	5131.	5141.	5151.	5161.	5171.	5181.	5191.	5201.	5211.	5221.
5231.	5241.	5251.	5261.	5271.	5281.	5291.	5301.	5311.	5321.	5331.	5341.	5351.	5361.	5371.	5381.	5391.
5401.	5411.	5421.	5431.	5441.	5451.	5461.	5471.	5481.	5491.	5501.	5511.	5521.	5531.	5541.	5551.	5561.
5571.	5581.	5591.	5601.	5611.	5621.	5631.	5641.	5651.	5661.	5671.	5681.	5691.	5701.	5711.	5721.	5731.
5741.	5751.	5761.	5771.	5781.	5791.	5801.	5811.	5821.	5831.	5841.	5851.	5861.	5871.	5881.	5891.	5901.
5911.	5921.	5931.	5941.	5951.	5961.	5971.	5981.	5991.	6001.	6011.	6021.	6031.	6041.	6051.	6061.	6071.
6081.	6091.	6101.	6111.	6121.	6131.	6141.	6151.	6161.	6171.	6181.	6191.	6201.	6211.	6221.	6231.	6241.
6251.	6261.	6271.	6281.	6291.	6301.	6311.	6321.	6331.	6341.	6351.	6361.	6371.	6381.	6391.	6401.	6411.
6421.	6431.	6441.	6451.	6461.	6471.	6481.	6491.	6501.	6511.	6521.	6531.	6541.	6551.	6561.	6571.	6581.
6591.	6601.	6611.	6621.	6631.	6641.	6651.	6661.	6671.	6681.	6691.	6701.	6711.	6721.	6731.	6741.	6751.
6761.	6771.	6781.	6791.	6801.	6811.	6821.	6831.	6841.	6851.	6861.	6871.	6881.	6891.	6901.	6911.	6921.
6931.	6941.	6951.	6961.	6971.	6981.	6991.	7001.	7011.	7021.	7031.	7041.	7051.	7061.	7071.	7081.	7091.
7101.	7111.	7121.	7131.	7141.	7151.	7161.	7171.	7181.	7191.	7201.	7211.	7221.	7231.	7241.	7251.	7261.
7271.	7281.	7291.	7301.	7311.	7321.	7331.	7341.	7351.	7361.	7371.	7381.	7391.	7401.	7411.	7421.	7431.
7441.	7451.	7461.	7471.	7481.	7491.	7501.	7511.	7521.	7531.	7541.	7551.	7561.	7571.	7581.	7591.	7601.
7611.	7621.	7631.	7641.	7651.	7661.	7671.	7681.	7691.	7701.	7711.	7721.	7731.	7741.	7751.	7761.	7771.
7781.	7791.	7801.	7811.	7821.	7831.	7841.	7851.	7861.	7871.	7881.	7891.	7901.	7911.	7921.	7931.	7941.
7951.	7961.	7971.	7981.	7991.	8001.	8011.	8021.	8031.	8041.	8051.	8061.	8071.	8081.	8091.	8101.	8111.
8121.	8131.	8141.	8151.	8161.	8171.	8181.	8191.	8201.	8211.	8221.	8231.	8241.	8251.	8261.	8271.	8281.
8291.	8301.	8311.	8321.	8331.	8341.	8351.	8361.	8371.	8381.	8391.	8401.	8411.	8421.	8431.	8441.	8451.
8461.	8471.	8481.	8491.	8501.	8511.	8521.	8531.	8541.	8551.	8561.	8571.	8581.	8591.	8601.	8611.	8621.
8631.	8641.	8651.	8661.	8671.	8681.	8691.	8701.	8711.	8721.	8731.	8741.	8751.	8761.	8771.	8781.	8791.
8801.	8811.	8821.	8831.	8841.	8851.	8861.	8871.	8881.	8891.	8901.	8911.	8921.	8931.	8941.	8951.	8961.
8971.	8981.	8991.	9001.	9011.	9021.	9031.	9041.	9051.	9061.	9071.	9081.	9091.	9101.	9111.	9121.	9131.
9141.	9151.	9161.	9171.	9181.	9191.	9201.	9211.	9221.	9231.	9241.	9251.	9261.	9271.	9281.	9291.	9301.
9311.	9321.	9331.	9341.	9351.	9361.	9371.	9381.	9391.	9401.	9411.	9421.	9431.	9441.	9451.	9461.	9471.
9481.	9491.	9501.	9511.	9521.	9531.	9541.	9551.	9561.	9571.	9581.	9591.	9601.	9611.	9621.	9631.	9641.
9651.	9661.	9671.	9681.	9691.	9701.	9711.	9721.	9731.	9741.	9751.	9761.	9771.	9781.	9791.	9801.	9811.
9821.	9831.	9841.	9851.	9861.	9871.	9881.	9891.	9901.	9911.	9921.	9931.	9941.	9951.	9961.	9971.	9981.
9991.	10001.	10011.	10021.	10031.	10041.	10051.	10061.	10071.	10081.	10091.	10101.	10111.	10121.	10131.	10141.	10151.
10161.	10171.	10181.	10191.	10201.	10211.	10221.	10231.	10241.	10251.	10261.	10271.	10281.	10291.	10301.	10311.	10321.
10331.	10341.	10351.	10361.	10371.	10381.	10391.	10401.	10411.	10421.	10431.	10441.	10451.	10461.	10471.	10481.	10491.
10501.	10511.	10521.	10531.	10541.	10551.	10561.	10571.	10581.	10591.	10601.	10611.	10621.	10631.	10641.	10651.	10661.
10671.	10681.	10691.	10701.	10711.	10721.	10731.	10741.	10751.	10761.	10771.	10781.	10791.	10801.	10811.	10821.	10831.
10841.	10851.	10861.	10871.	10881.	10891.	10901.	10911.	10921.	10931.	10941.	10951.	10961.	10971.	10981.	10991.	11001.
11011.	11021.	11031.	11041.	11051.	11061.	11071.	11081.	11091.	11101.	11111.	11121.	11131.	11141.	11151.	11161.	11171.
11181.	11191.	11201.	11211.	11221.	11231.	11241.	11251.	11261.	11271.	11281.	11291.	11301.	11311.	11321.	11331.	11341.
11351.	11361.	11371.	11381.	11391.	11401.	11411.	11421.	11431.	11441.	11451.	11461.	11471.	11481.	11491.	11501.	11511.
11521.	11531.	11541.	11551.	11561.	11571.	11581.	11591.	11601.	11611.	11621.	11631.	11641.	11651.	11661.	11671.	11681.
11691.	11701.	11711.	11721.	11731.	11741.	11751.	11761.	11771.	11781.	11791.	11801.	11811.	11821.	11831.	11841.	11851.
11861.	11871.	11881.	11891.	11901.	11911.	11921.	11931.	11941.	11951.	11961.	11971.	11981.	11991.	12001.	12011.	12021.
12031.	12041.	12051.	12061.	12071.	12081.	12091.	12101.	12111.	12121.	12131.	12141.	12151.	12161.	12171.	12181.	12191.
12201.	12211.	12221.	12231.	12241.	12251.	12261.	12271.	12281.	12291.	12301.	12311.	12321.	12331.	12341.	12351.	12361.
12371.	12381.	12391.	12401.	12411.	12421.	12431.	12441.	12451.	12461.	12471.	12481.	12491.	12501.	12511.	12521.	12531.
12541.	12551.	12561.	12571.	12581.	12591.	12601.	12611.	12621.	12631.	12641.	12651.	12661.	12671.	12681.	12691.	12701.
12711.	12721.	12731.	12741.	12751.	12761.	12771.	12781.	12791.	12801.	12811.	12821.	12831.	12841.	12851.	12861.	12871.

PEAR OUTFLOW IS 1080C. AT TIME 17.75 HOURS

	PERK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10880	7100	2031	2031	38650
GMS	398	204	58	58	1653
INCHES		7.35	8.30	8.30	6.30
MM		186.59	212.70	212.70	210.70
AL-11		3568	4098	4229	4029
AL-12		4401	4976	4976	4976
AL-13					
AL-14					
AL-15					
AL-16					
AL-17					
AL-18					
AL-19					
AL-20					
AL-21					
AL-22					
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AL-26					
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AL-28					
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AL-42					
AL-43					
AL-44					
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AL-72					
AL-73					
AL-74					
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AL-82					
AL-83					
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AL-88					
AL-89					
AL-90					
AL-91					
AL-92					
AL-93					
AL-94					
AL-95					
AL-96					
AL-97					
AL-98					
AL-99					

STATION 20, PLAN 1, RAY10 7

ALTERNATIVE	SOLUTION	DID NOT CONVERGE	PERIOD	74	SUB-STEP 1	CONTINUITY BALANCE	TIME
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 75	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.17 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 76	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.25 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 77	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.33 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 78	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.42 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 79	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.50 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 80	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.58 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 81	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.67 HR
ESTIMATED	N.S. ELEV	5.66250E+02	PERIOD 82	SUB-STEP 1	CONTINUITY BALANCE	-1.10350E+00	0.75 HR

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW									
C.	0.	6.	C.	0.	C.	0.	C.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	2.	2.	2.	3.	3.
3.	4.	5.	5.	5.	7.	7.	8.	9.	9.
5.	10.	12.	13.	13.	16.	15.	16.	17.	17.
18.	19.	20.	22.	22.	24.	25.	27.	28.	28.
29.	30.	31.	32.	32.	41.	41.	43.	51.	51.
53.	53.	56.	56.	56.	60.	61.	65.	65.	65.
66.	68.	70.	72.	72.	77.	81.	83.	86.	86.
85.	92.	95.	98.	101.	107.	110.	114.	117.	117.
120.	125.	127.	130.	137.	140.	145.	147.	150.	150.
153.	157.	161.	164.	167.	171.	178.	183.	185.	185.
187.	192.	195.	199.	202.	206.	210.	212.	213.	213.
214.	216.	217.	218.	220.	222.	224.	225.	227.	227.
229.	231.	232.	235.	237.	247.	257.	269.	281.	281.
293.	298.	302.	304.	306.	311.	313.	316.	318.	318.
321.	324.	327.	330.	331.	336.	339.	349.	359.	359.
353.	356.	360.	362.	367.	379.	383.	394.	404.	404.
406.	410.	415.	420.	421.	433.	435.	444.	454.	454.
460.	463.	468.	473.	479.	481.	483.	494.	504.	504.
507.	510.	515.	520.	521.	533.	535.	544.	554.	554.
560.	563.	568.	573.	579.	581.	583.	594.	604.	604.
607.	610.	615.	620.	621.	633.	635.	644.	654.	654.
660.	663.	668.	673.	679.	681.	683.	694.	704.	704.
707.	710.	715.	720.	721.	733.	735.	744.	754.	754.
760.	763.	768.	773.	779.	781.	783.	794.	804.	804.
807.	810.	815.	820.	821.	833.	835.	844.	854.	854.
860.	863.	868.	873.	879.	881.	883.	894.	904.	904.
907.	910.	915.	920.	921.	933.	935.	944.	954.	954.
960.	963.	968.	973.	979.	981.	983.	994.	1004.	1004.
1007.	1010.	1015.	1020.	1021.	1033.	1035.	1044.	1054.	1054.
1060.	1063.	1068.	1073.	1079.	1081.	1083.	1094.	1104.	1104.
1107.	1110.	1115.	1120.	1121.	1133.	1135.	1144.	1154.	1154.
1160.	1163.	1168.	1173.	1179.	1181.	1183.	1194.	1204.	1204.
1207.	1210.	1215.	1220.	1221.	1233.	1235.	1244.	1254.	1254.
1260.	1263.	1268.	1273.	1279.	1281.	1283.	1294.	1304.	1304.
1307.	1310.	1315.	1320.	1321.	1333.	1335.	1344.	1354.	1354.
1360.	1363.	1368.	1373.	1379.	1381.	1383.	1394.	1404.	1404.
1407.	1410.	1415.	1420.	1421.	1433.	1435.	1444.	1454.	1454.
1460.	1463.	1468.	1473.	1479.	1481.	1483.	1494.	1504.	1504.
1507.	1510.	1515.	1520.	1521.	1533.	1535.	1544.	1554.	1554.
1560.	1563.	1568.	1573.	1579.	1581.	1583.	1594.	1604.	1604.
1607.	1610.	1615.	1620.	1621.	1633.	1635.	1644.	1654.	1654.
1660.	1663.	1668.	1673.	1679.	1681.	1683.	1694.	1704.	1704.
1707.	1710.	1715.	1720.	1721.	1733.	1735.	1744.	1754.	1754.
1760.	1763.	1768.	1773.	1779.	1781.	1783.	1794.	1804.	1804.
1807.	1810.	1815.	1820.	1821.	1833.	1835.	1844.	1854.	1854.
1860.	1863.	1868.	1873.	1879.	1881.	1883.	1894.	1904.	1904.
1907.	1910.	1915.	1920.	1921.	1933.	1935.	1944.	1954.	1954.
1960.	1963.	1968.	1973.	1979.	1981.	1983.	1994.	2004.	2004.
2007.	2010.	2015.	2020.	2021.	2033.	2035.	2044.	2054.	2054.
2060.	2063.	2068.	2073.	2079.	2081.	2083.	2094.	2104.	2104.
2107.	2110.	2115.	2120.	2121.	2133.	2135.	2144.	2154.	2154.
2160.	2163.	2168.	2173.	2179.	2181.	2183.	2194.	2204.	2204.
2207.	2210.	2215.	2220.	2221.	2233.	2235.	2244.	2254.	2254.
2260.	2263.	2268.	2273.	2279.	2281.	2283.	2294.	2304.	2304.
2307.	2310.	2315.	2320.	2321.	2333.	2335.	2344.	2354.	2354.
2360.	2363.	2368.	2373.	2379.	2381.	2383.	2394.	2404.	2404.
2407.	2410.	2415.	2420.	2421.	2433.	2435.	2444.	2454.	2454.
2460.	2463.	2468.	2473.	2479.	2481.	2483.	2494.	2504.	2504.
2507.	2510.	2515.	2520.	2521.	2533.	2535.	2544.	2554.	2554.
2560.	2563.	2568.	2573.	2579.	2581.	2583.	2594.	2604.	2604.
2607.	2610.	2615.	2620.	2621.	2633.	2635.	2644.	2654.	2654.
2660.	2663.	2668.	2673.	2679.	2681.	2683.	2694.	2704.	2704.
2707.	2710.	2715.	2720.	2721.	2733.	2735.	2744.	2754.	2754.
2760.	2763.	2768.	2773.	2779.	2781.	2783.	2794.	2804.	2804.
2807.	2810.	2815.	2820.	2821.	2833.	2835.	2844.	2854.	2854.
2860.	2863.	2868.	2873.	2879.	2881.	2883.	2894.	2904.	2904.
2907.	2910.	2915.	2920.	2921.	2933.	2935.	2944.	2954.	2954.
2960.	2963.	2968.	2973.	2979.	2981.	2983.	2994.	3004.	3004.
3007.	3010.	3015.	3020.	3021.	3033.	3035.	3044.	3054.	3054.
3060.	3063.	3068.	3073.	3079.	3081.	3083.	3094.	3104.	3104.
3107.	3110.	3115.	3120.	3121.	3133.	3135.	3144.	3154.	3154.
3160.	3163.	3168.	3173.	3179.	3181.	3183.	3194.	3204.	3204.
3207.	3210.	3215.	3220.	3221.	3233.	3235.	3244.	3254.	3254.
3260.	3263.	3268.	3273.	3279.	3281.	3283.	3294.	3304.	3304.
3307.	3310.	3315.	3320.	3321.	3333.	3335.	3344.	3354.	3354.
3360.	3363.	3368.	3373.	3379.	3381.	3383.	3394.	3404.	3404.
3407.	3410.	3415.	3420.	3421.	3433.	3435.	3444.	3454.	3454.
3460.	3463.	3468.	3473.	3479.	3481.	3483.	3494.	3504.	3504.
3507.	3510.	3515.	3520.	3521.	3533.	3535.	3544.	3554.	3554.
3560.	3563.	3568.	3573.	3579.	3581.	3583.	3594.	3604.	3604.
3607.	3610.	3615.	3620.	3621.	3633.	3635.	3644.	3654.	3654.
3660.	3663.	3668.	3673.	3679.	3681.	3683.	3694.	3704.	3704.
3707.	3710.	3715.	3720.	3721.	3733.	3735.	3744.	3754.	3754.
3760.	3763.	3768.	3773.	3779.	3781.	3783.	3794.	3804.	3804.
3807.	3810.	3815.	3820.	3821.	3833.	3835.	3844.	3854.	3854.
3860.	3863.	3868.	3873.	3879.	3881.	3883.	3894.	3904.	3904.
3907.	3910.	3915.	3920.	3921.	3933.	3935.	3944.	3954.	3954.
3960.	3963.	3968.	3973.	3979.	3981.	3983.	3994.	4004.	4004.
4007.	4010.	4015.	4020.	4021.	4033.	4035.	4044.	4054.	4054.
4060.	4063.	4068.	4073.	4079.	4081.	4083.	4094.	4104.	4104.
4107.	4110.	4115.	4120.	4121.	4133.	4135.	4144.	4154.	4154.
4160.	4163.	4168.	4173.	4179.	4181.	4183.	4194.	4204.	4204.
4207.	4210.	4215.	4220.	4221.	4233.	4235.	4244.	4254.	4254.
4260.	4263.	4268.	4273.	4279.	4281.	4283.	4294.	4304.	4304.
4307.	4310.	4315.	4320.	4321.	4333.	4335.	4344.	4354.	4354.
4360.	4363.	4368.	4373.	4379.	4381.	4383.	4394.	4404.	4404.
4407.	4410.	4415.	4420.	4421.	4433.	4435.	4444.	4454.	4454.
4460.	4463.	4468.	4473.	4479.	4481.	4483.	4494.	4504.	4504.
4507.	4510.	4515.	4520.	4521.	4533.	4535.	4544.	4554.	4554.
4560.	4563.	4568.	4573.	4579.	4581.	4583.	4594.	4604.	4604.
4607.	4610.	4615.	4620.	4621.	4633.	4635.	4644.	4654.	4654.
4660.	4663.	4668.	4673.	4679.	4681.	4683.	4694.	4704.	4704.
4707.	4710.	4715.	4720.	4721.	4733.	4735.	4744.	4754.	4754.
4760.	4763.	4768.	4773.	4779.	4781.	4783.	4794.	4804.	4804.
4807.	4810.	4815.	4820.	4821.	4833.	4835.	4844.	4854.	4854.
4860.	4863.	4868.	4873.	4879.	4881.	4883.	4894.	4904.	4904.
4907.	4910.	4915.	4920.	4921.	4933.	4935.	4944.	4954.	4954.
4960.	4963.	4968.	4973.	4979.	4981.	4983.	4994.	5004.	5004.
5007.	5010.	5015.	5020.	5021.	5033.	5035.	5044.	5054.	5054.
5060.	5063.	5068.	5073.	5079.	5081.	5083.	5094.	5104.	5104.
5107.	5110.	5115.	5120.	5121.	5133.	5135.	5144.	5154.	5154.
5160.	5163.	5168.	5173.	5179.	5181.	5183.	5194.	5204.	5204.
5207.	5210.	5215.	5220.	5221.	5233.	5235.	5244.	5254.	5254.
5260.	5263.	5268.	5273.	5279.	5281.	5283.	5294.	5304.	5304.
5307.	5310.	5315.	5320.	5321.	5333.	5335.	5344.	5354.	5354.
5360.	5363.	5368.	5373.	5379.	5381.	5383.	5394.	5404.	5404.
5407.	5410.	5415.	5420.	5421.	5433.	5435.	5444.	5454.	5454.
5460.	5463.	5468.	5473.	5479.	5481.	5483.	5494.	5504.	5504.
5507.	5510.	5515.	5520.	5521.	5533.	5535.	5544.	5554.	5554.
5560.	5563.	5568.	5573.	5579.	5581.	5583.	5594.	5604.	5604.
5607.	5610.	5615.	5620.	5621.	5633.	5635.	5644.	5654.	5654.
5660.	5663.	5668.	5673.	5679.	5681.	5683.	5694.	5704.	5704.
5707.	5710.	5715.	5720.	5721.	5733.	5735.	5744.	5754.	5754.
5760.	5763.	5768.	5773.	5779.	5781.	5783.	5794.	5804.	5804.
5807.	5810.	5815.	5820.	5821.	5833.	5835.	5844.	5854.	5854.
5860.	5863.	5868.	5873.	5879.	5881.	5883.	5894.	5904.	5904.
5907.	5910.	5915.	5920.	5921.	5933.	5935.	5944.	5954.	5954.
5960.	5963.	5968.	5973.	5979.	5981.	5983.	5994.	6004.	6004.
6007.	6010.	6015.	6020.	6021.	6033.	6035.	6044.	6054.	6054.
6060.	6063.	6068.	6073.	6079.	6081.	6083.	6094.	6104.	6104.
6107.	6110.	6115.	6120.	6121.	6133.	6135.	6144.	6154.	6154.
6160.	6163.	6168.	6173.	6179.	6181.	6183.	6194.	6204.	6204.
6207.	6210.	6215.	6220.	6221.	6233.	6235.	6244.	6254.	6254.
6260.	6263.	6268.	6273.	6279.	6				

P	CONTINUITY BALANCE	-2,522,001.00
	61	8-S
	CONTINUITY BALANCE	5.00
		-2,522,001.00
PERIOD 62	SUB-STEP 1	TIME 5.17 HR
	CONTINUITY BALANCE	-1,046,142.01

PROJECT 9457: DATE 20 MAR 81 PAGE 399
PROGRAM W21/92-1V TIME 17:48:24 CASE C2

PROGRAM W21102-1V TIME 17:48:24 CASE C2

PERIOD 120	SUM-STEP 1	TIME 10.00 HR
CONTINUITY BALANCE		3.103791+00

END-OF-PELQID HYDROGRAPH ORDINATES

[illegible][illegible]

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				.15	.20	.25	.30	.35	.40	.45	.50	1.00
HYDROGRAPH AT	1	.32	1	519.	692.	865.	1038.	1211.	1384.	1557.	1730.	3460.
	(	.83)	(	16.72)	19.69	24.50	29.39	34.29	39.19	44.09	48.99	97.98
ROUTED TO	2	.32	1	161.	1468.	1559.	1641.	1741.	2189.	2157.	1725.	2733.
	(	.83)	(	4.57)	41.57	44.15	46.47	49.51	61.97	61.07	48.85	77.40
ROUTED TO	3	.72	1	136.	1121.	1237.	1332.	1440.	1694.	1598.	1331.	2045.
	(	.83)	(	3.86)	31.75	35.03	37.71	40.77	47.90	45.26	37.70	57.91
HYDROGRAPH AT	4	.76	1	959.	1277.	1596.	1915.	2234.	2553.	2873.	3192.	6383.
	(	1.97)	(	27.11)	36.15	45.19	54.23	63.27	72.30	81.34	90.38	180.76
ROUTED TO	5	.76	1	290.	622.	4491.	4819.	5120.	5412.	5667.	6601.	5594.
	(	1.97)	(	8.21)	17.61	127.76	136.45	144.97	153.25	160.47	186.93	158.42
ROUTED TO	6	.76	1	271.	538.	3897.	4173.	4401.	4638.	4887.	5456.	4742.
	(	1.97)	(	7.69)	15.22	110.34	118.15	124.63	131.32	138.40	154.49	134.29
HYDROGRAPH AT	7	1.01	1	1286.	1715.	2144.	2573.	3002.	3431.	3859.	4288.	8577.
	(	2.61)	(	36.43)	48.57	60.72	72.86	85.00	97.14	109.29	121.43	242.86
ROUTED TO	8	1.01	1	207.	402.	4312.	4547.	4794.	5520.	5300.	4660.	5192.
	(	2.61)	(	5.86)	11.59	122.12	127.75	135.76	156.36	150.09	131.95	147.02
ROUTED TO	9	1.01	1	200.	356.	3546.	3817.	4081.	4669.	4582.	4073.	4900.
	(	2.61)	(	5.66)	11.22	100.42	108.09	115.57	132.21	129.75	115.35	138.75
HYDROGRAPH AT	10	2.76	1	2404.	3266.	4007.	4809.	5610.	6412.	7213.	8015.	16030.
	(	7.14)	(	68.09)	90.70	113.48	136.18	158.87	181.57	204.26	226.96	453.92
4 COMBINED	11	4.84	1	2731.	4173.	9813.	11692.	13432.	15439.	15926.	18537.	27498.
	(	12.55)	(	77.33)	118.16	277.84	331.09	380.34	437.19	450.98	524.92	778.67
HYDROGRAPH AT	12	.26	1	544.	751.	939.	1127.	1315.	1503.	1491.	1379.	3757.
	(	.93)	(	15.94)	21.20	26.80	31.92	37.24	42.54	47.88	53.20	106.39
ROUTED TO	13	.76	1	199.	311.	414.	1955.	2101.	2236.	2310.	2348.	2918.
	(	.93)	(	5.60)	8.60	11.79	55.37	59.51	63.32	65.41	66.48	82.63
ROUTED TO	14	.36	1	128.	183.	241.	880.	978.	1075.	1174.	1257.	1834.

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1				PLAN 1				PLAN 1				PLAN 1			
RATIO CF PRI	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	RATIO CF PRI	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.35	86.12	.00	59.	161.	.00	16.17	.00	.35	86.12	.00	59.	161.	.00	16.17	.00
.20	87.02	.22	67.	1468.	.35	16.83	15.92	.20	87.02	.22	67.	1468.	.35	16.83	15.92
.25	87.37	.37	76.	1500.	.48	16.62	15.75	.25	87.37	.37	76.	1500.	.48	16.62	15.75
.30	87.53	.57	71.	1651.	.52	16.54	15.67	.30	87.53	.57	71.	1651.	.52	16.54	15.67
.35	87.63	.83	72.	1732.	.58	16.48	15.58	.35	87.63	.83	72.	1732.	.58	16.48	15.58
.40	87.75	.55	69.	2203.	.71	16.12	15.25	.40	87.75	.55	69.	2203.	.71	16.12	15.25
.45	86.91	.39	60.	2157.	.37	15.87	14.67	.45	86.91	.39	60.	2157.	.37	15.87	14.67
.50	86.95	.35	66.	1710.	.42	15.29	14.33	.50	86.95	.35	66.	1710.	.42	15.29	14.33
1.00	87.11	.31	67.	2733.	.52	15.83	12.58	1.00	87.11	.31	67.	2733.	.52	15.83	12.58

PLAN 3				PLAN 3				PLAN 3				PLAN 3			
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	136.	65.3	16.43	.15	136.	65.3	16.43	.15	136.	65.3	16.43	.15	136.	65.3	16.43
.20	1421.	71.1	16.92	.20	1421.	71.1	16.92	.20	1421.	71.1	16.92	.20	1421.	71.1	16.92
.25	1237.	71.4	16.75	.25	1237.	71.4	16.75	.25	1237.	71.4	16.75	.25	1237.	71.4	16.75
.30	1332.	71.7	16.67	.30	1332.	71.7	16.67	.30	1332.	71.7	16.67	.30	1332.	71.7	16.67
.35	1440.	72.0	16.58	.35	1440.	72.0	16.58	.35	1440.	72.0	16.58	.35	1440.	72.0	16.58
.40	1694.	72.6	16.33	.40	1694.	72.6	16.33	.40	1694.	72.6	16.33	.40	1694.	72.6	16.33
.45	1598.	72.4	15.43	.45	1598.	72.4	15.43	.45	1598.	72.4	15.43	.45	1598.	72.4	15.43
.50	1331.	71.7	15.62	.50	1331.	71.7	15.62	.50	1331.	71.7	15.62	.50	1331.	71.7	15.62
1.00	2045.	73.4	16.08	1.00	2045.	73.4	16.08	1.00	2045.	73.4	16.08	1.00	2045.	73.4	16.08

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1									
RATIO OF POT	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	TOP OF DAM	
	ELEVATION		INITIAL VALUE	SPILLWAY CREST				112.00	118.70
	STORAGE		93.	93.				214.	
	OUTFLOW		0.	0.				780.	
.15	117.44	.00	186.	290.	.00	16.67	.00		
.20	118.35	.00	207.	622.	.00	16.33	.00		
.25	119.03	.33	221.	4543.	.44	16.96	16.00		
.30	119.38	.68	226.	4972.	.56	16.81	15.83		
.35	119.60	.90	232.	5123.	.60	16.75	15.75		
.40	119.72	1.02	234.	5412.	.67	16.67	15.67		
.45	119.78	1.08	236.	5607.	.71	16.58	15.58		
.50	119.74	.04	215.	6001.	.31	16.00	15.00		
1.00	118.99	.20	220.	5594.	.54	14.00	13.00		

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW-CFS	MAXIMUM STAGE-FT	TIME HOURS
.15	271.	91.0	17.42
.20	338.	92.1	16.47
.25	3897.	97.6	17.08
.30	4173.	97.9	16.92
.35	4401.	98.1	16.83
.40	4638.	98.3	16.75
.45	4887.	98.5	16.67
.50	5456.	99.1	16.08
1.00	4742.	98.4	16.25

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 122.00 126. 0.	SPILLWAY CREST 122.00 128. 0.	TOP OF DAM 129.10 378. 498.		
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	127.92	276.	207.	.00	18.25	.00
.20	128.78	306.	452.	.00	17.33	.00
.25	129.55	334.	4313.	.65	17.08	16.08
.30	129.99	350.	4547.	.77	16.83	15.83
.35	130.22	358.	4794.	.85	16.67	15.67
.40	129.95	348.	5520.	1.00	16.25	15.25
.45	129.41	329.	5300.	.71	15.83	14.83
.50	129.48	331.	4660.	.73	15.50	14.50
1.00	129.67	378.	5192.	.83	16.17	12.67

PLAN 1 STATION 9

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	200.	100.1	12.50
.20	306.	101.0	17.75
.25	3546.	106.2	17.25
.30	3817.	106.5	17.00
.35	4081.	106.7	16.83
.40	4669.	107.2	16.42
.45	4582.	107.1	16.08
.50	4073.	106.7	16.00
1.00	4900.	107.4	16.42

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 95.00 25. 0.	SPILLWAY CREST 95.00 25. 0.	TOP OF DAM 101.30 88. 478.			
RATIO OF PMF	MAXIMUM RESERVOIR W.S.-ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	99.92	.00	88.	198.	.00	16.17	.00
.20	100.49	.00	76.	311.	.00	16.08	.00
.25	101.00	.00	83.	416.	.00	16.08	.00
.30	101.45	.15	96.	1582.	.35	16.81	15.92
.35	101.74	.44	94.	2131.	.48	16.75	15.83
.40	101.96	.66	97.	2271.	.54	16.67	15.75
.45	102.11	.83	99.	2377.	.60	16.60	15.67
.50	102.31	1.01	102.	2419.	.62	16.62	15.67
1.00	101.49	.18	90.	2018.	.50	15.92	13.58

PLAN 1 STATION 14

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	128.	84.4	16.00
.20	183.	85.0	17.67
.25	241.	85.6	17.42
.30	600.	87.3	17.00
.35	978.	87.5	16.92
.40	1075.	87.7	16.83
.45	1174.	88.0	16.83
.50	1257.	88.2	16.83
1.00	1834.	89.0	16.25

SUPMARY OF DAM SAFETY ANALYSIS

PLAN 1									
RATIO CF P-1	MAXIMUM RESERVOIR U.S.ELEV	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 94.00 27. 0.	SPILLWAY CREST 94.00 27. 0.	TOP OF DAM 101.00 89. 1048.	DURATION OVER TOP HOURS	MAXIMUM OUTFLOW CFS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	98.90					.00	321.	16.08	.00
.20	99.40					.00	471.	16.00	.00
.25	99.84					.00	601.	16.00	.00
.30	100.27					.00	760.	16.00	.00
.35	100.66					.00	917.	16.00	.00
.40	101.04					.00	1586.	16.02	15.92
.45	101.26					.33	1649.	16.83	15.83
.50	101.46					.37	1690.	16.83	15.83
1.00	102.32					.71	3519.	15.90	15.58

PLAN 1 STATION 17

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	103.	86.5	17.00
.20	238.	87.1	16.23
.25	333.	87.7	16.67
.30	428.	88.1	16.58
.35	534.	88.3	16.50
.40	1026.	89.2	17.08
.45	1114.	89.3	17.00
.50	1186.	89.5	17.00
1.00	2024.	91.0	16.67

BLOCK B VEATCH
 PROJECT 9457: DATE 20 MAR 81 PAGE 400
 FLOOD HYDROGRAPH PACKAGE - REC-1
 PROGRAM M21/02-TV TIME 17:48:24 CASE C2

SUPMARY OF DAM SAFETY ANALYSIS

PLAN 1

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	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 906.30 424. 0.	SPILLWAY CREST 906.30 424. 0.	TOP OF DAM 928.50 3963. 11791.			
RATIO OF P/F	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TYPE OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	920.11	.00	2030.	360.	.00	24.50	.00
.20	922.64	.00	2466.	1792.	.00	19.50	.00
.25	925.14	.00	2973.	5298.	.00	18.42	.00
.30	926.33	.00	3252.	7437.	.00	18.02	.00
.35	927.22	.00	3503.	9268.	.00	17.83	.00
.40	927.88	.00	3789.	10880.	.00	17.75	.00
.45	928.48	.18	4037.	12165.	1.08	17.67	.00
.50	928.99	.69	4252.	13365.	2.08	17.67	.00
1.00	931.59	3.29	5338.	36810.	4.83	16.83	.00

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